Iron and Steel ENGINEER

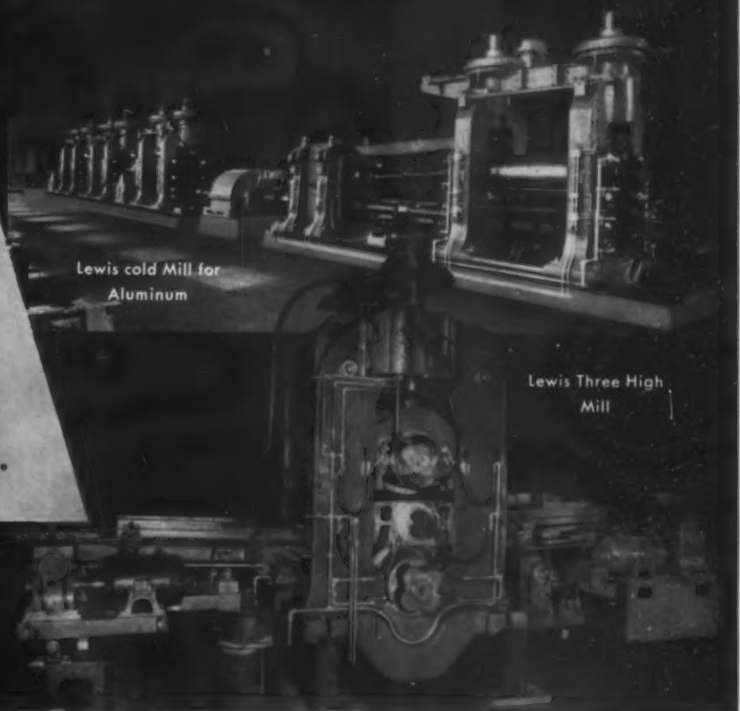
ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | MAY, 1942 | PITTSBURGH, PA.

CHNOLOGY DEPT.

LEWIS ROLLING MILLS

Rolling Mill operators depend upon LEWIS products for accuracy of gauge in rolling, simplicity of operation, rugged construction and "built-in" improvements which always accord with the latest rolling practice.

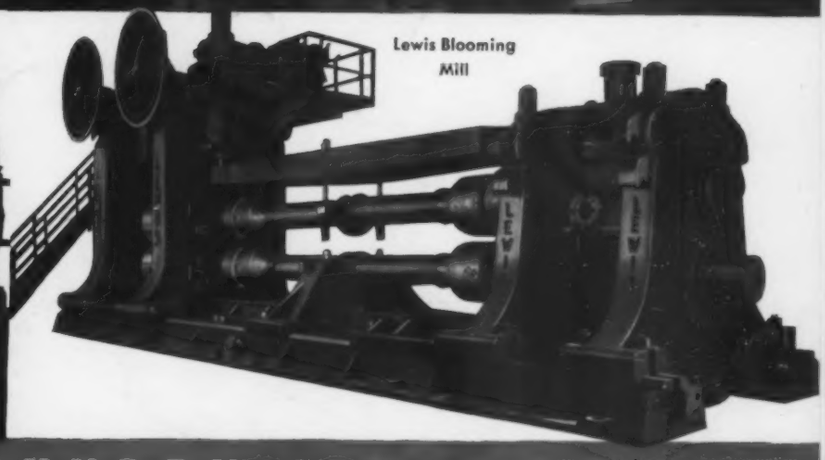


Lewis cold Mill for Aluminum

Lewis Three High Mill

Lewis Merchant Mill

Lewis Non-Ferrous Precision Mill



Lewis Blooming Mill

LEWIS ROLLS step up tonnage

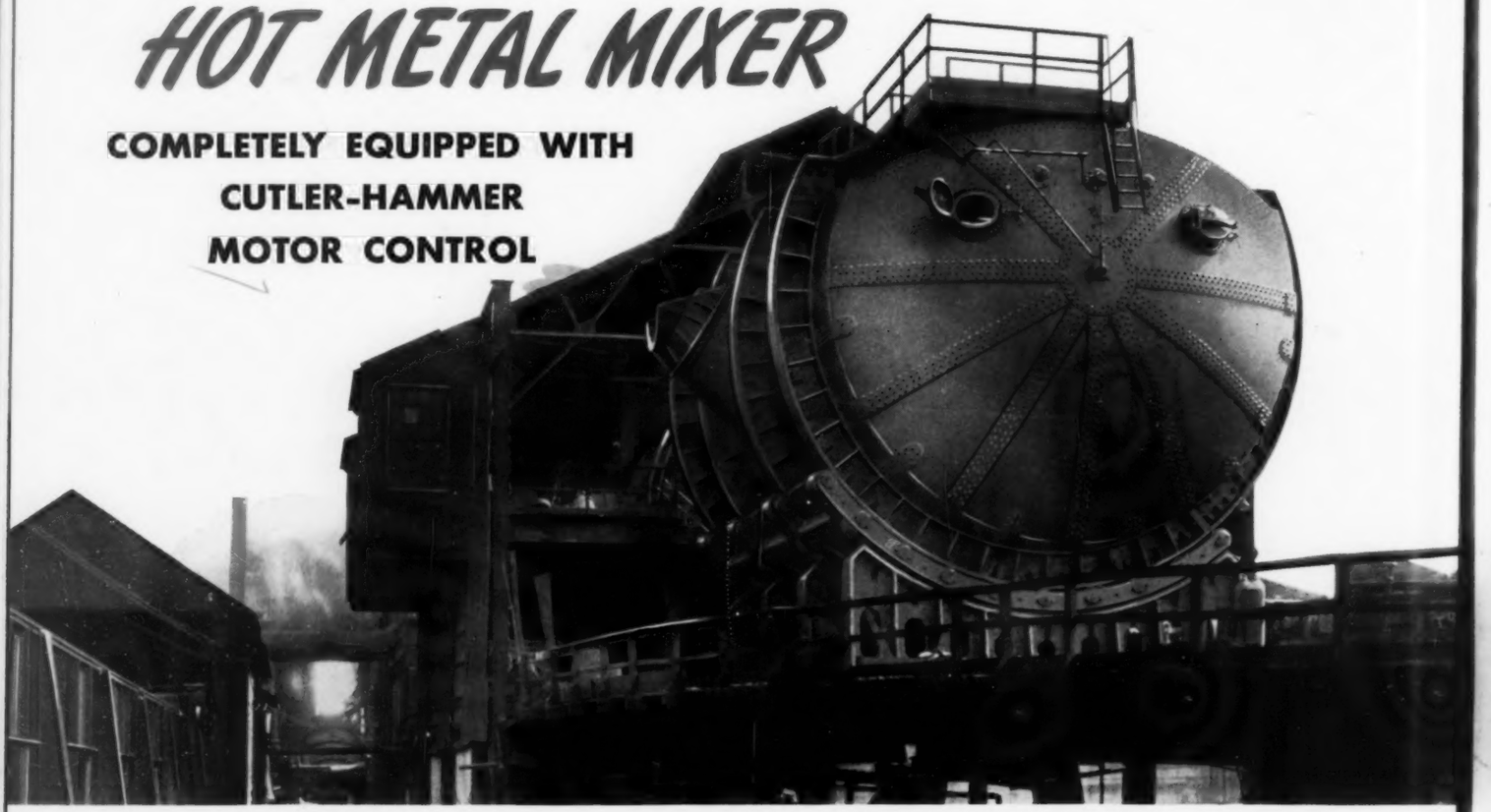
LEWIS FOUNDRY & MACHINE

DIVISION OF BLAW-KNOX CO.

PITTSBURGH, PA.

GIANT 1700 TON HOT METAL MIXER

COMPLETELY EQUIPPED WITH CUTLER-HAMMER MOTOR CONTROL



It is significant that when the lives of men and the safety of equipment depend upon the flawless operation of machines, you find so many equipped with Cutler-Hammer Motor Control.

Handling molten metal in steel mills, for example, is, at best, a most hazardous job. The confidence shown by the builders of the 1700 ton Hot Metal Mixer shown here, in equipping it with Cutler-Hammer Motor Control, springs directly from Cutler-Hammer's 50 years of Steel Mill Motor Control experience, and from the *world-wide reputation for dependability and performance* Cutler-Hammer has achieved during that time.

Consult C-H engineers when faced with your next perplexing Motor Control problem . . . and always keep in mind that Cutler-Hammer Control, superbly engineered to each specific application, is available for every steel mill job—straight through from the blast furnaces to the finishing mills. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee, Wis. Associate: Canadian Cutler-Hammer Ltd., Toronto.

The simple inductive time limit principle of Cutler-Hammer Ltl Motor Control, such as used on this giant mixer, provides smooth, controlled acceleration and deceleration which are important when handling molten iron which will splash at the slightest jerk; and its graduated dynamic braking principle means that the mixer may be accurately inched for fast, safe pouring. It provides return speeds faster than pouring speeds, so that flow may be quickly broken in case of emergency. And, of course, Ltl may be interlocked with battery-generator sets or air engines so that in case of power failure, spills may be avoided. The graphite and metallic dusts which fill the air around blast furnaces cause no trouble in *any* Cutler-Hammer Motor Control. For only the famous C-H dust-safe *vertical* contacts are used in Cutler-Hammer equipment.

1892-1942 50th ANNIVERSARY

CUTLER-HAMMER
MOTOR CONTROL
C-H

We KNOW HOW THEY FELT!

Those men who earned the first Navy E, back in 1906, must have been the proudest crew of tars in the fleet. We know, for we feel the same bursting pride today. The blue Navy burgee now flying from our flagstaff sends a special thrill through every man in our plant. We're proud to be Americans.

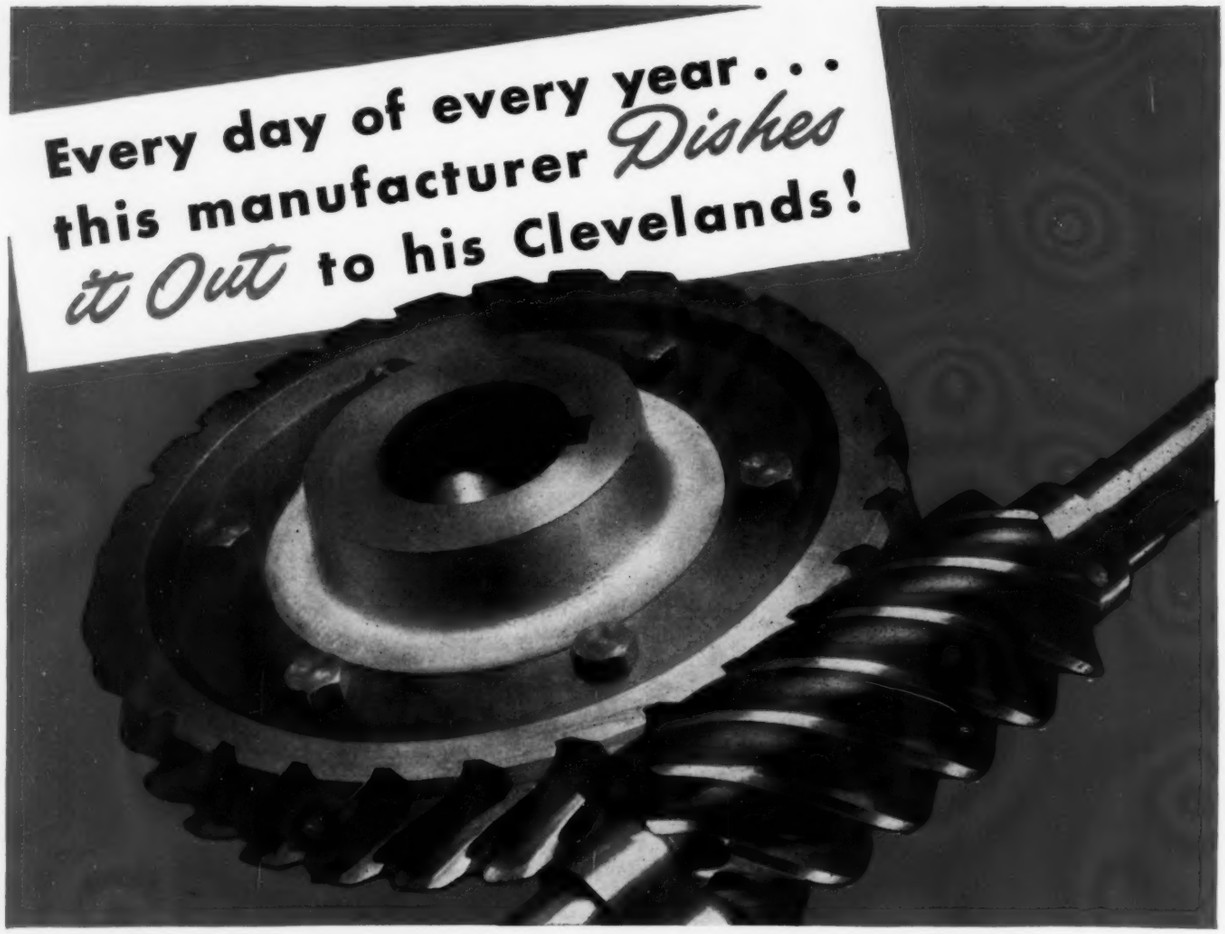
The Navy E is not lightly given, nor lightly received. It means more than Excellence. It stands for a good job well done, for teamwork better than the best . . . and its award to any civilian plant should double and redouble fighting spirit. From now until final Victory dawns, we pledge every effort to help *Keep America Rolling.*

Exide
IRONCLAD
BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia

The World's Largest Manufacturers of Storage Batteries for Every Purpose

Exide Batteries of Canada, Limited, Toronto



Here's a job that dishes out nothing but punishment to its speed reducers all the time—a job that Cleveland Units have licked consistently since 1929.

The largest Manufacturer in his Industry—now fully engaged in War production—has more than 100 Cleveland Worm Gear Speed Reducers that have never let him down.

His statement "Clevelands help us avoid shutdowns" is an extra-fine tribute—

For not only must he run his plants day and night, but must keep each machine working continuously.

Even a brief shutdown could stop operation for weeks!

Put your peak loads on Clevelands. They can "take it!"

The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication
In Canada: PEACOCK BROTHERS LIMITED

CLEVELAND
WORM GEAR *Speed Reducers*

HYDROPRESS · INC.

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS
PUMPS · ACCUMULATORS

570 LEXINGTON AVENUE • NEW YORK • N. Y.

Typical Factory Assembled Controller.

Reversing Dynamic Braking Controller Class 9530.

MORE TONNAGE... LESS TIME OUT

with Westinghouse Steel Mill Control

Fewer time-outs for contactor maintenance . . . less time required for each maintenance job . . . those two facts mean more production.

Westinghouse controllers are engineered from years of steel mill experience to take the constant punishment of twenty-four hour daily service. They're built to take it—with the minimum number of time-outs for maintenance. When replacements are needed, they can be made with a minimum interruption of production.

Complete factory assembly of Westinghouse controllers saves delays for field erection . . . gives you a ready-to-use installation as soon as incoming and outgoing connections are made, whether for control of a single motor or auxiliaries for an entire mill. Write for booklet B-2265 for details and useful application data. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

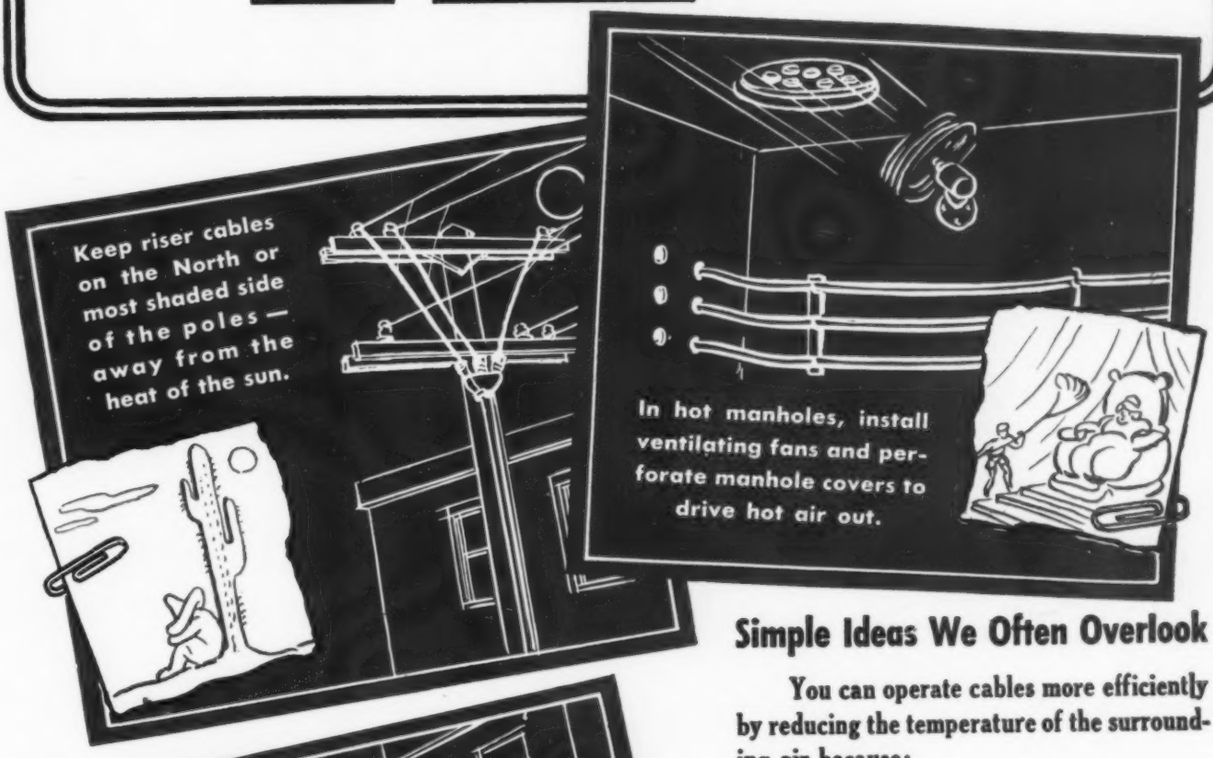
J-21155

Westinghouse Type SM Contactors STAY ON THE JOB

SM contactors reduce "time-outs," because the rapid motion and quick extinction of the arc minimize burning. Contact tips are extra heavy, easily replaceable. Bearing pins and bushings are of long-life nitrided alloy steel. Vacuum and pressure impregnated coil is protected against moisture, dirt, metallic dust.

Westinghouse STEEL MILL CONTROL

How to Make Wires and Cables LAST LONGER Outdoors . . .


Keep riser cables on the North or most shaded side of the poles — away from the heat of the sun.
In hot manholes, install ventilating fans and perforate manhole covers to drive hot air out.

Simple Ideas We Often Overlook

You can operate cables more efficiently by reducing the temperature of the surrounding air because:

1. the insulation will last longer with the same conductor load, or
2. more current can be carried in the same cable without shortening its life.

Where current carrying capacity is not a factor (as with signal and control cables), lower ambient temperatures prolong the life of any insulation—especially rubber.

THE OKONITE COMPANY
Offices in principal cities
Passaic, N. J.

• Make the most of your present cables — copper, rubber, lead and other cable components are vital to our war production and must be conserved. And call on Okonite Engineers for suggestions on the best way to install, operate and maintain your electric circuits.

OKONITE
Insulated Wires and Cables

IN AMERICA'S PRODUCTION FOR VICTORY...WHERE DOES AETNA FIT YOUR PICTURE?

Steel is a victory essential and rolls play a vital part in steel production. Aetna Iron Base Rolls have been "time-tested" in many of America's leading steel plants. Engineered for quick change-overs and maximum wear, they will fit efficiently into your victory picture.

PLAIN CHILL AND MOLY CHILL ROLLS • ALANITE AND ALANITE SPECIAL ROLLS • ASEX AND ASEX SPECIAL ROLLS • FORMING, WELDING AND SIZING MILL ROLLS • ROLLS FOR RUBBER AND PLASTIC MILLS

The **AETNA-STANDARD**
ENGINEERING COMPANY
GENERAL OFFICES
YOUNGSTOWN, OHIO, U.S.A.

ASSOCIATED COMPANIES
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND •
• JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Designers and Builders to the Steel, Non-ferrous and Chemical Industries

FOR VICTORY'S SAKE

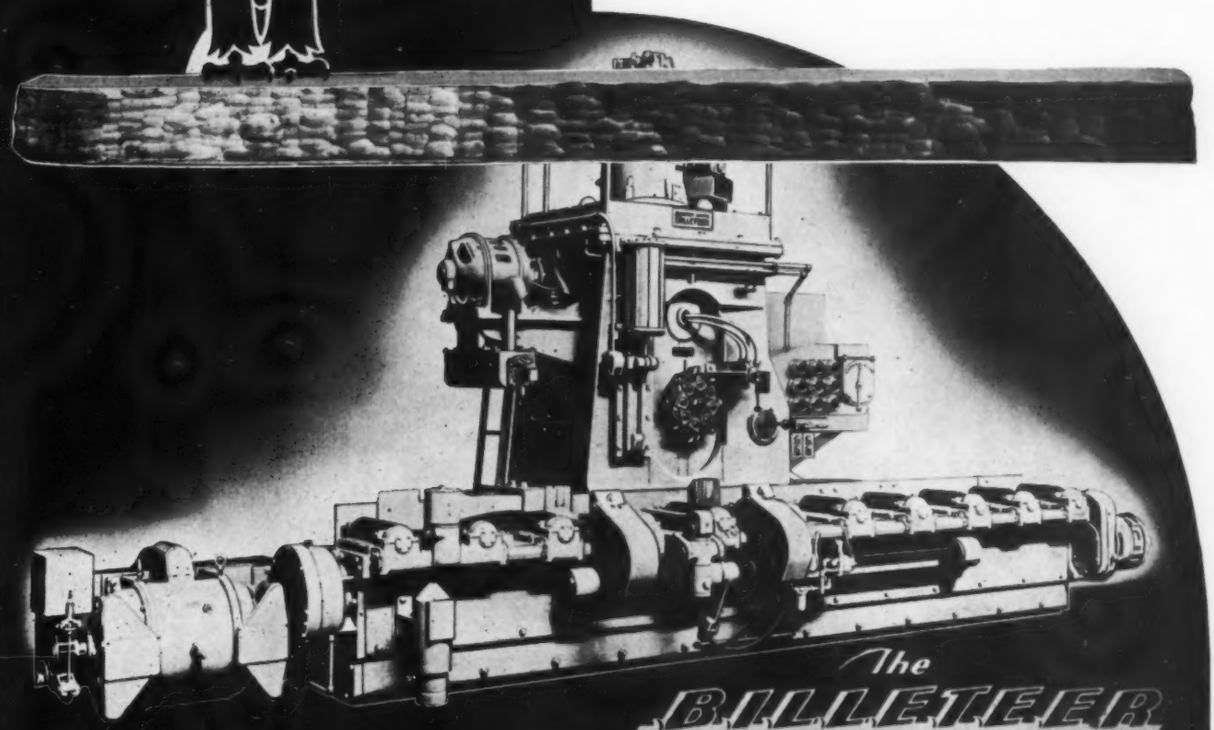
DON'T *Waste Time* CLEANING BILLETS BY HAND

Victory is a production job. Every hour saved in getting out priority steel brings Victory closer. And you can save plenty of hours with a Billeteer.

A billet cleaning job that now takes you 20 man-hours by hand, can be done in ONE or TWO hours with a Billeteer. The cleaning *speed* of the Billeteer is, in itself, a worthwhile contribution toward ultimate Victory. But fully as important is the fact that the 18 man-hours saved out of the 20 can be applied to other important jobs.

And after Victory is finally won — the Billeteer is one piece of equipment that will figure prominently in your efforts to keep production costs at a minimum.

Very high priority rating is given this equipment. Orders have been coming in fast. For Victory's sake — *don't delay.*

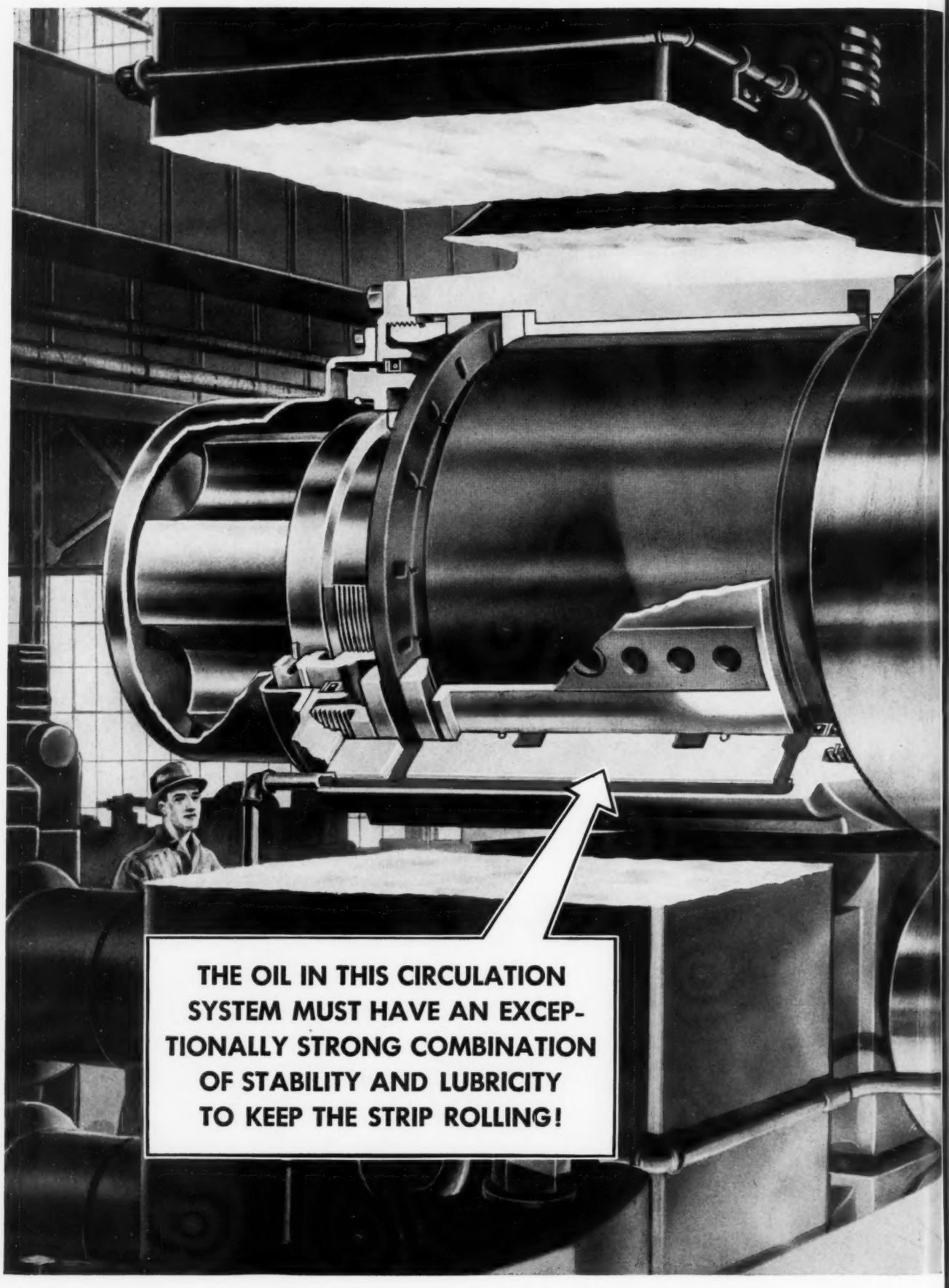


The BILLETEER

Complete unit consists of feed skids, Billeteer, and runout table. All movements power driven under finger-tip control of ONE operator. Remarkably flexible in operation.

BUILDERS OF BONNOT-LENTZ BILLETEERS ALSO CRUSHING PULVERIZING AND MIXING EQUIPMENT

THE Bonnot COMPANY
STEEL EQUIPMENT DIVISION
CANTON, OHIO


THE OIL IN THIS CIRCULATION SYSTEM MUST HAVE AN EXCEPTIONALLY STRONG COMBINATION OF STABILITY AND LUBRICITY TO KEEP THE STRIP ROLLING!

Take the "Load" off Your Shoulders!

HERE'S A DEPENDABLE ANSWER TO ONE OF YOUR IMPORTANT OPERATING PROBLEMS:

Problem: Modern roll neck bearings must bear the brunt of severe operating conditions. They are subject to almost unbelievable loads. And they must help roll out steel that is accurately controlled to tolerances measured in thousandths of an inch.

One manufacturer says that in designing its bearings "full advantage had been taken of the tremendous load-carrying ability of oil." That's why in circulation-oiled bearings like the "oil film bearing" at the left you must have an oil with high lubricity and stability.

Answer: *Gargoyle Vacuoline Oils* were created to give these two important characteristics to the greatest degree possible. In extensive tests, these oils proved to possess an exceptionally strong combination of stability and lubricity. Gargoyle Vacuoline Oils separate quickly from water and impurities. They resist oxidation and formation of deposits... keep oiling systems clean. They give the best protection an oil can give against shutdowns due to bearing failure.

THE BEARING AT THE LEFT IS MADE BY THE MORGAN CONSTRUCTION COMPANY

TO HELP MAINTAIN WARTIME PRODUCTION, CALL IN

SOCONY-VACUUM for "Correct Lubrication"

GARGOYLE Lubricants

SOCONY-VACUUM OIL CO., INC. — Standard Oil of N. Y. Div. — White Star Div. Lubrite Div. — Chicago Div. — White Eagle Div. — Wadhams Div. — Southeastern Div. (Baltimore) — Magnolia Petroleum Company — General Petroleum Corporation of Calif.

SWINDELL FURNACES IN FOUR WARS have made METAL FOR VICTORY!

today

. . . modern Swindell Electric Furnaces such as this are speeding production of fine steels for better implements of war—as faithfully and effectively as Swindell products have served since the simple iron furnaces of ninety years ago.

Present-day Swindell design, saving *time and labor* with swinging roof for rapid top-charging, features exclusive integrated construction which assures smooth performance under capacity-plus demands.

SWINDELL-DRESSLER *Corporation*

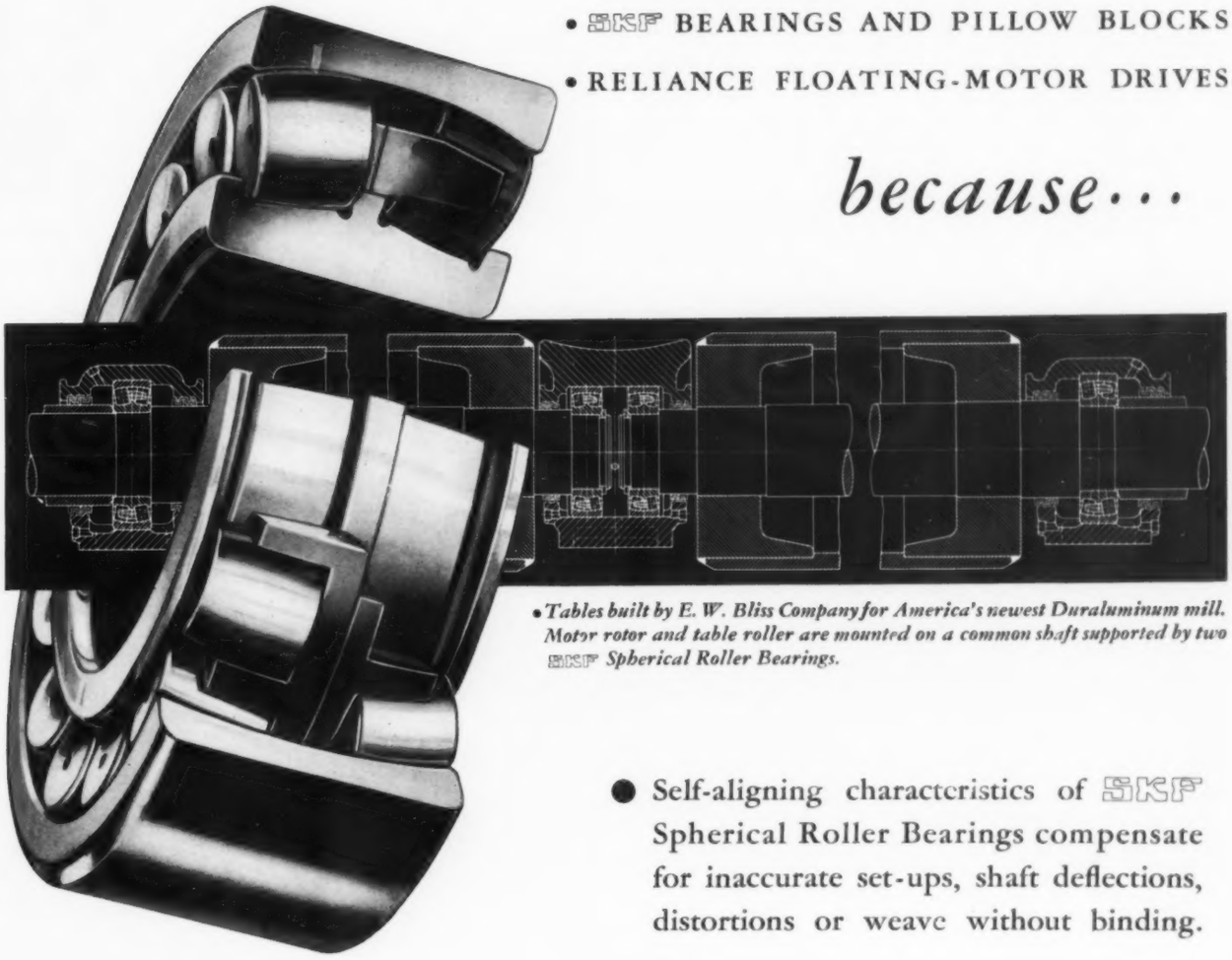
DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH, PA.

A "natural" TABLE *design:*

- SKF BEARINGS AND PILLOW BLOCKS
- RELIANCE FLOATING-MOTOR DRIVES

because...



• Tables built by E. W. Bliss Company for America's newest Duraluminum mill. Motor rotor and table roller are mounted on a common shaft supported by two SKF Spherical Roller Bearings.

- Self-aligning characteristics of SKF Spherical Roller Bearings compensate for inaccurate set-ups, shaft deflections, distortions or weave without binding.
- Full capacity is always available for useful work.
- Bearing trouble is eliminated. 5039

SKF INDUSTRIES, INC., PHILADELPHIA, PA.

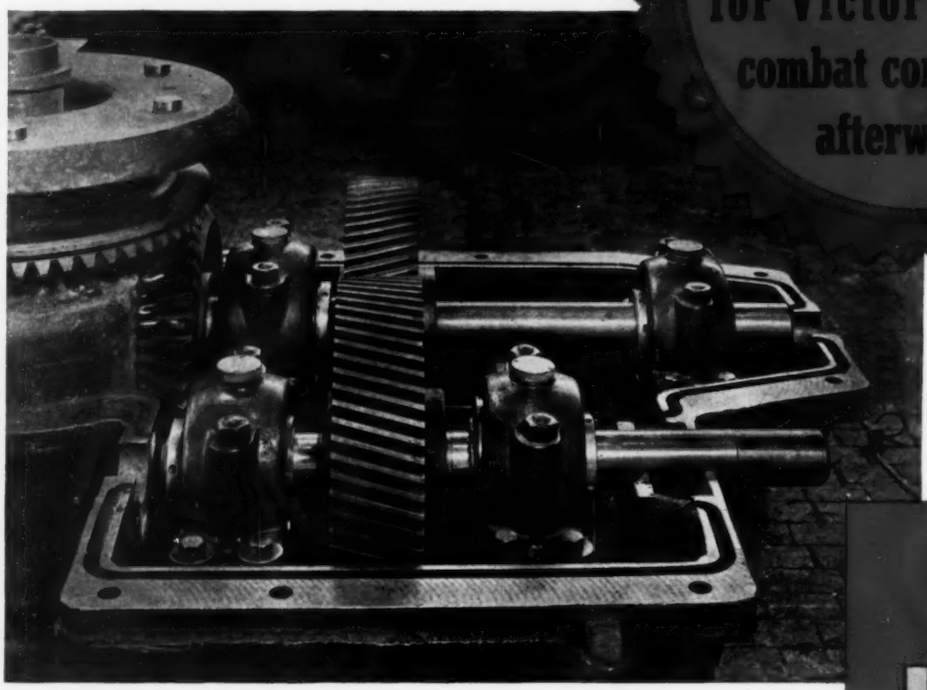
SKF

BALL AND ROLLER BEARINGS

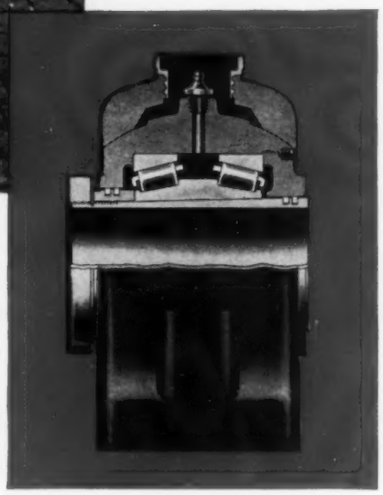
TO ASSURE VICTORY
BUY UNITED STATES
DEFENSE BONDS & STAMPS

Timken Bearings assure speed and endurance for Victory—and to combat competition afterwards.

Dodge-Timken 4 7/16" Special Duty Adapter Type Pillow Blocks as used in this wire mill drive.



Sectional view of the Dodge Special Duty Adapter Type Pillow Block showing the application of Timken Bearings.



The wire reel drive shown above is installed in one of the country's largest wire mills. It originally had babbitted bearings, but later was anti-frictionized, Dodge-Timken Pillow Blocks being used to support both the high and slow speed shafts.

As a result of the change-over the following economies have been effected: 16 hours of labor saved; 80 tons of wire saved; and appreciable savings in power and lubricant.

Furthermore, shaft wear was stopped instantly; and correct alignment of shafts and gears assured for the extended life of the equipment.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; and Timken Rock Bits.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

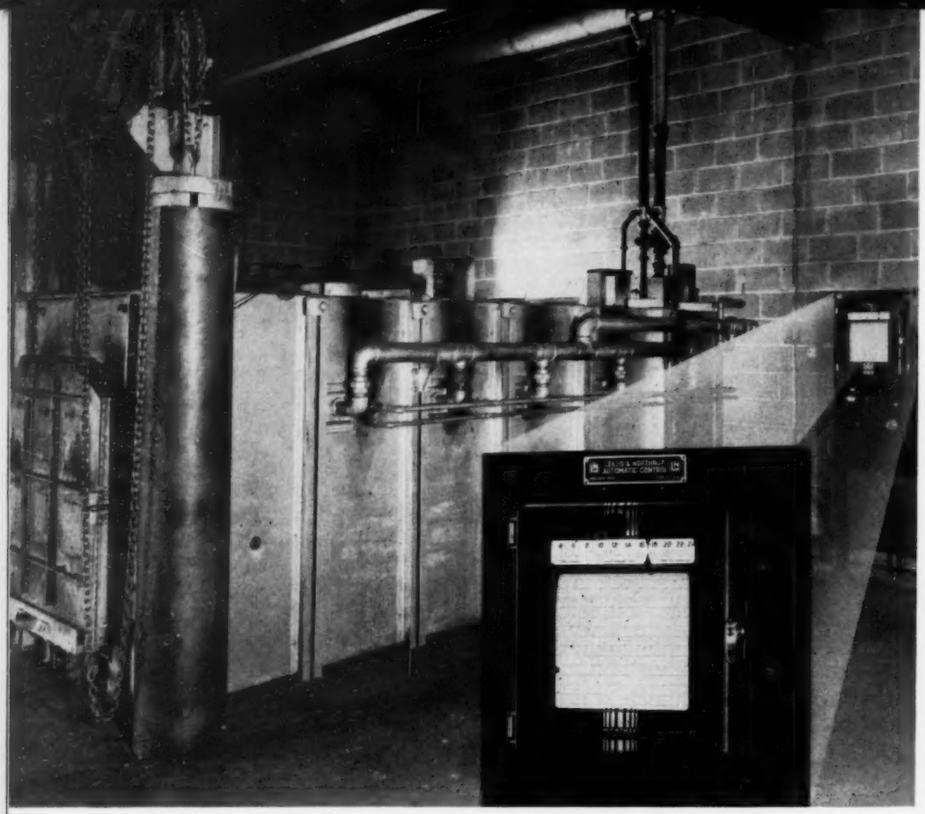
Lewis ROLLS

BETTER FINISH INCREASED TONNAGE

Night and day in the battle for increased production of both heavy and light steel plate, LEWIS ROLLS are out in front—as always.

LEWIS FOUNDRY & MACHINE
DIVISION OF BLAW-KNOX CO.
PITTSBURGH, PA.

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and non-ferrous industries



Because of the kind of work it's doing right now, no photograph may be taken of the furnace referred to below, but this picture shows a unit of comparable gas consumption.

100,000 Ft of Gas Per Month Saved for War Use by Micromax

When a new industrial furnace was being installed in a certain plant, the orders failed for some reason to include a control pyrometer. The furnace was badly needed, however, so it was fired up under manual control, while its Micromax Controller was being rushed to the job. The before-and-after results of Micromax Control were most interesting.

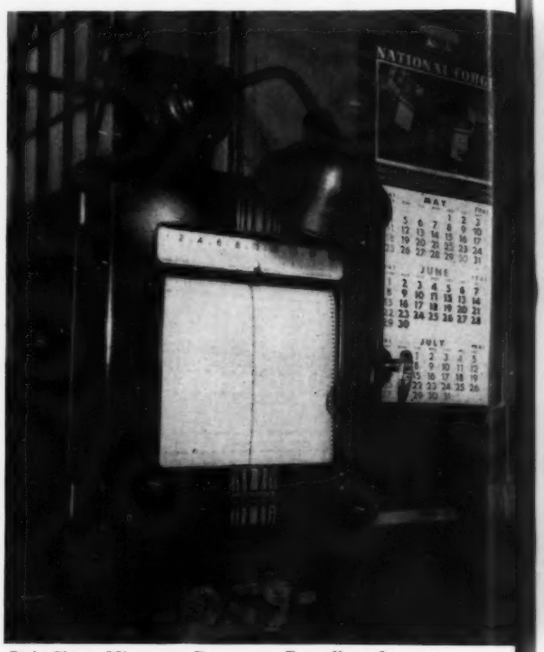
The first result, when Micromax was installed, was a cheer from the foreman, because he was tired of tending the furnace by hand. Next, management cheered, because the furnace's gas bill dropped $50 per month. And finally the gas company joined in, because the saving gave them 100,000 feet more fuel per month, urgently needed by other war plants. This 100,000 feet was ten per cent of the furnace's fuel.

The Micromax qualities which made possible maximum savings in this case are available to every user, and are often as valuable on old furnaces as on new ones. For Micromax Controllers can be quickly applied to any furnace. Thousands are doing fine jobs by simply opening a by-pass valve wide when temperature drops and closing it tight when temperature rises again. Other thousands use a control in which the valve moves *in proportion* whenever there's a temperature change. This is control at its best. It automatically does the right thing even when someone opens the furnace door; when the fuel pressure changes; when the furnace is loaded to capacity as well as when it's almost empty.

If you have a war-time job of temperature control, one of our engineers will be glad to talk it over with you, on request. Or perhaps you'd rather just have our Folder N-00A(1), which describes the Controller.

Correct Anneal of Guns Is Shown By Micromax In Big Ordnance Plant

Makers of big guns, periscope tubes, giant crankshafts and similar heavy forgings for the Army and Navy are generally required to prove, by pyrometer charts, that the annealing has been done as specified in orders. Many of these forgings makers rely on Micromax Pyrometers for this exacting duty; we show here some typical applications.



Strip-Chart Micromax Pyrometer Recording the anneal of a big gun barrel.

The strip-chart Micromax is one of a battery, located in a temperature-control room. The door is locked against all except inspectors, and the pyrometers thus give impartial reports of the annealing of "fighting" forgings.

Round-Chart Micromax guiding furnace operator.

The round-chart Micromax pyrometers are mounted right alongside the big annealing furnaces, to guide the operators in holding the temperatures reported by the strip-chart machines. Their big dials and bold arrows enable the men to see from a distance, without hovering continuously over them.

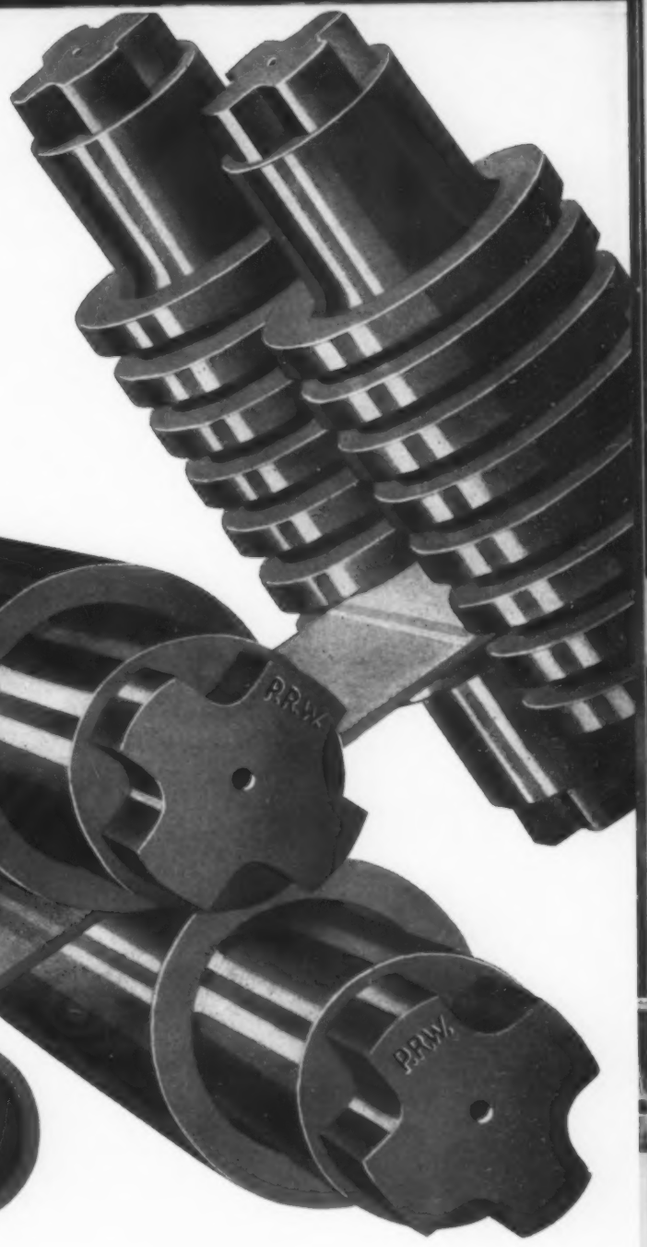
In addition to these two Micromax models shown, there are 3 others available in hundreds of ranges. One or another will handle any temperature problem of any industrial furnace. They are described in Catalog N-33A, sent on request.

Jrl Ad ENT-0600C(46)

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES



LESS COST PER TON OF STEEL ROLLED hoop

PITTSBURGH ROLLS are fitted to the demands of the times—stepping up production and reducing costs.

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX CO.—"Steel's Partner" • PITTSBURGH, PA.

Save Time and Money

here

with Heppenstall Shear Knives

Heppenstall Shear Knives require less grinding and deliver more cuts to the grind because they are made of special analysis alloy steel in Heppenstall's own electric induction furnaces according to methods developed through more than fifty years of quality shear knife manufacture.

Without any obligation, Heppenstall Engineering Service will gladly help you solve shear knife problems. And next time you order, specify Heppenstall. Use knives whose guaranteed high quality save you time and money. Write for full information, Heppenstall Company, Box E5, 4620 Hatfield Street, Pittsburgh, Pennsylvania.

Heppenstall

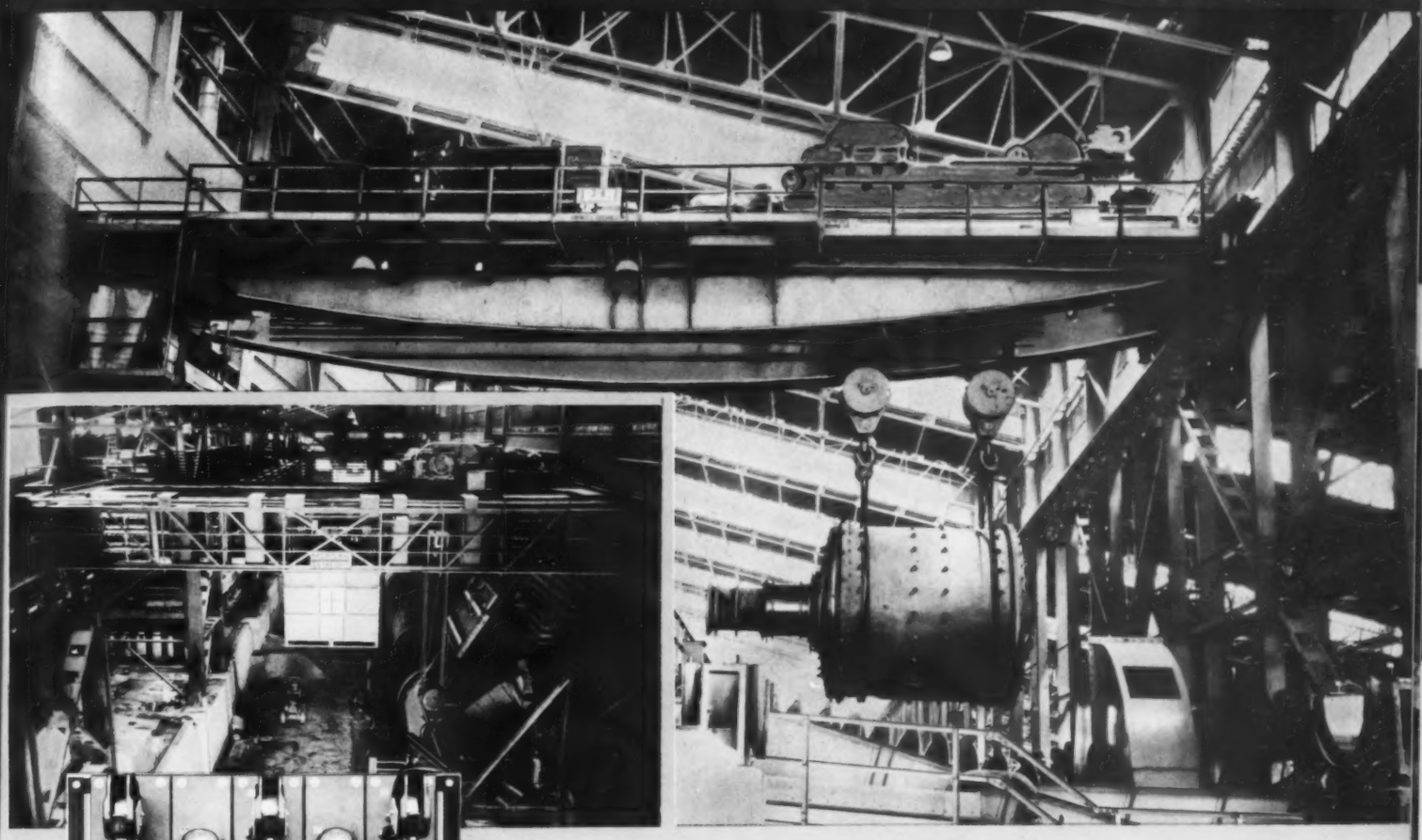
PITTSBURGH · BRIDGEPORT · DETROIT

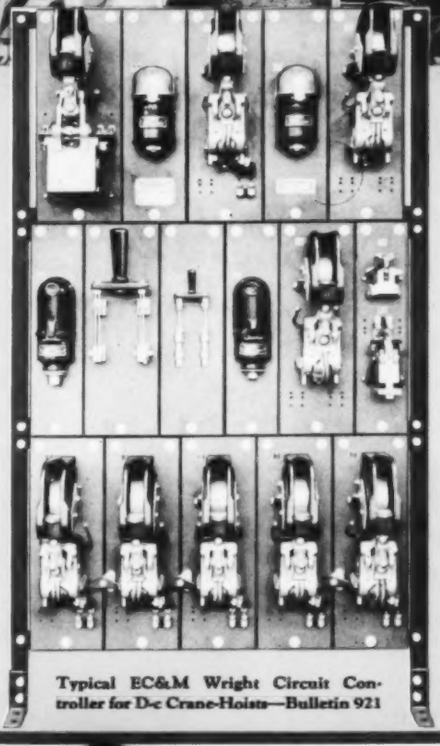
HEPPENSTALL H QUALITY

Forging Fine Steels For More Than Fifty Years

EC & M CRANE CONTROL

At Morenci Works of Phelps Dodge Corp.



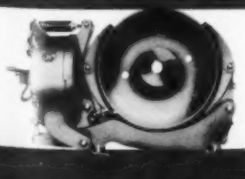


Typical EC&M Wright Circuit Controller for D-c Crane-Hoists—Bulletin 921

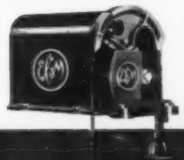
Assures Safe · Accurate Handling of BALL MILLS—LADLES, *etc.,*

Protects against damage when removing "Skulls" too

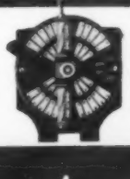
Wherever heavy equipment is to be spotted—hot metal to be handled—EC&M Crane Control is "first choice" of plant operating men, because—The EC&M Hoist Controller, of patented Wright Circuit design, is *unequalled* in its ability to permit *short, accurate, inching movements.* It is SAFE—*the motor can not overspeed.* The operator always has the load under absolute control when lowering capacity loads with the controller either in the full "on" position or on any intermediate points. Equally important on these cranes is the use of a "torque-limiting" relay in the hoist direction to prevent damage to crane or converter, during removal of "skulls." For efficient control matched to the task—and noted for low up-keep, too—specify EC&M Crane Control.



Type WB Brakes for D-c operation Bulletin 1004-C.



Youngstown Safety Limit Stops, A-c & D-c Bulletin1035-C



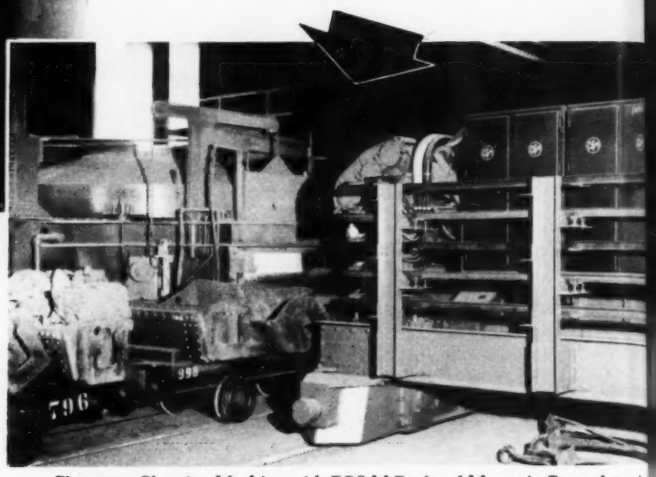
Manual Controllers Bu. 960, 980, 970.

Crane Protective Panels Bu. 1021, 1022.

WHEN BUYING CRANES, *Specify* **EC&M CONTROL**

Complete Control for EVERY TYP AND MAKE OF CRAN

25-Ton Portal Cranes completely equipped with EC&M LINE-ARC Contactor, Time-Current Control and Type WB Brakes.



Floor-type Charging Machine with EC&M Enclosed Magnetic Control servi recently installed electric furnaces.

You Can Set a Gun or Crack a Walnut—

The above statement expresses the fine degree of accuracy you have in an EC&M Magnetic Controller for hoist motions of cranes. Under any load condition, this controller is unequalled in its ability to permit short, accurate, inching movements.

"WITH EC&M CONTROL" is practically a by-word with crane-specification-writers. They do this with complete confidence for they know that these 3 simple words mean the best procurable equipment for the *vital* part of the crane.

At EC&M, there are no pre-set standards for Crane Control. Instead, Brakes, Limit Stops, Protective Panels and Controllers are designed and built for the task at hand. This insures that the crane starts up for the first time without delay and that smooth, low-cost operation is maintained throughout the life of the crane.

For a carefully engineered job, built with efficiently operating products such as—The Wright Circuit—LINE-ARC Contactors—Time-Current Acceleration—Type WB Brakes—A-c Dynamic Hoist-Control—A-c Frequency Relay Acceleration—Youngstown Safety Limit Stops, etc., we suggest you specify "With EC&M CONTROL" when buying new cranes or revamping old ones, either A-c or D-c operated.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 E. 79TH STREET CLEVELAND, OHIO

BUILT BY MORGAN *Engineering*

ROLLING ALUMINUM FOR DEFENSE

● Among the many types of mill equipment built by Morgan, is the above mill consisting of two 22″ and two 18″ 3-high stands driven by one 22″ 3-high and one 18″ 3-high pinion stand, for rolling aluminum shapes. With this installation was furnished three oil hydraulic cropping and cutting-off shears to handle up to 5″ x 5″ aluminum billets. On such equipment for maximum production, the rugged stability of Morgan Engineering is well established, long since proved by the largest producers.

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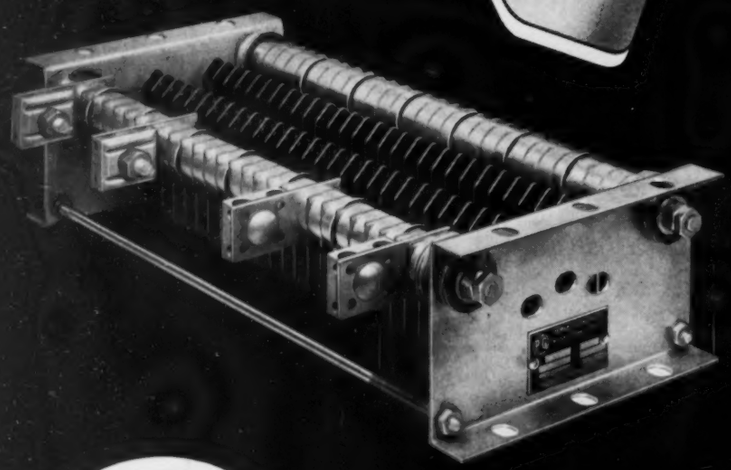

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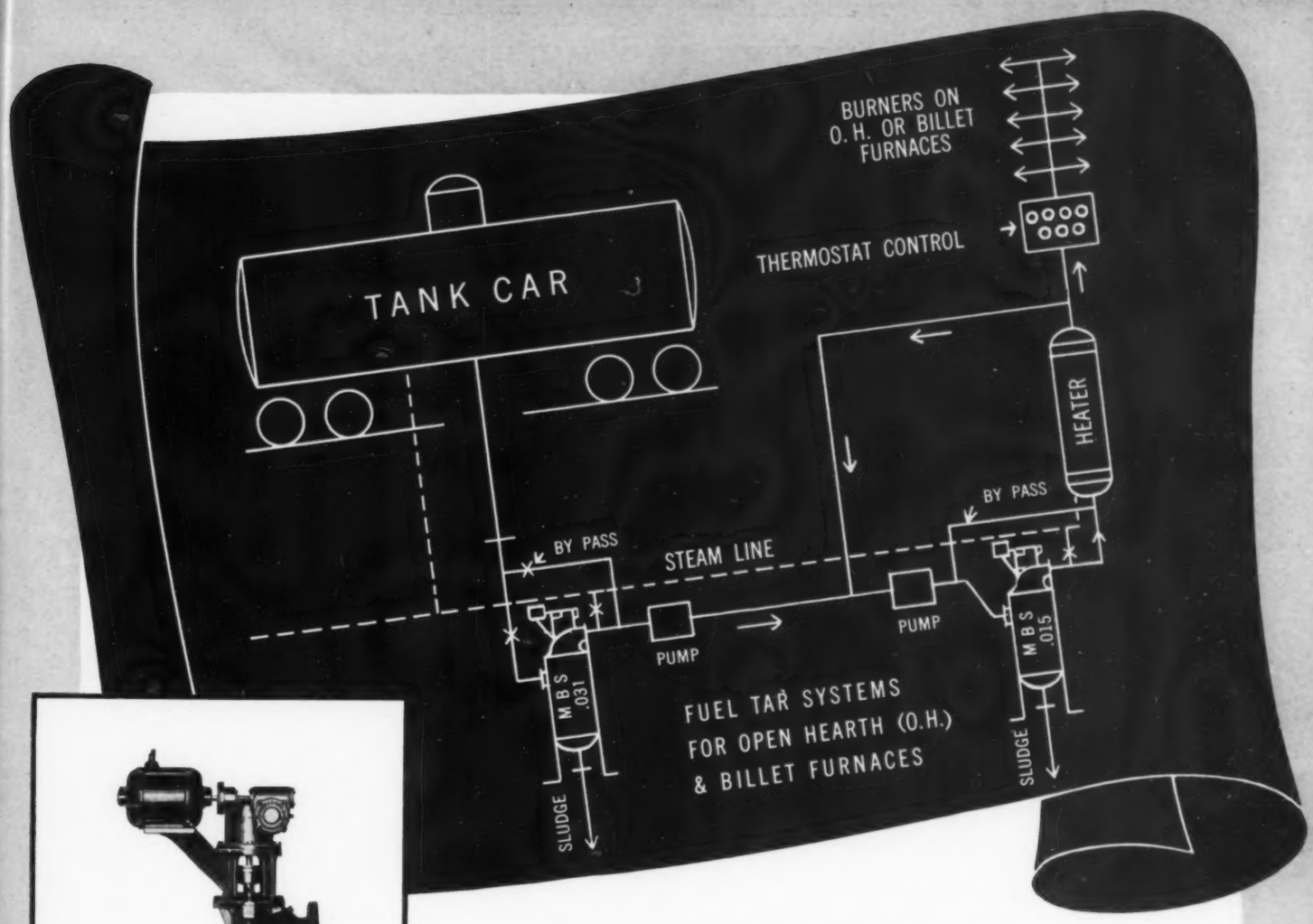

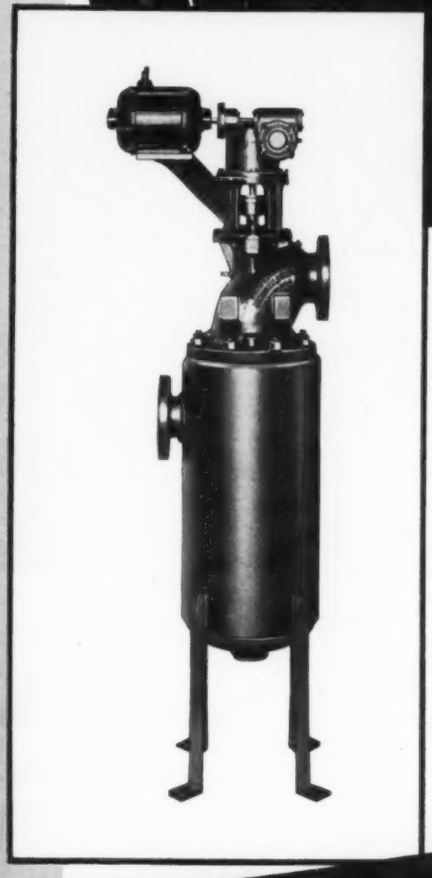

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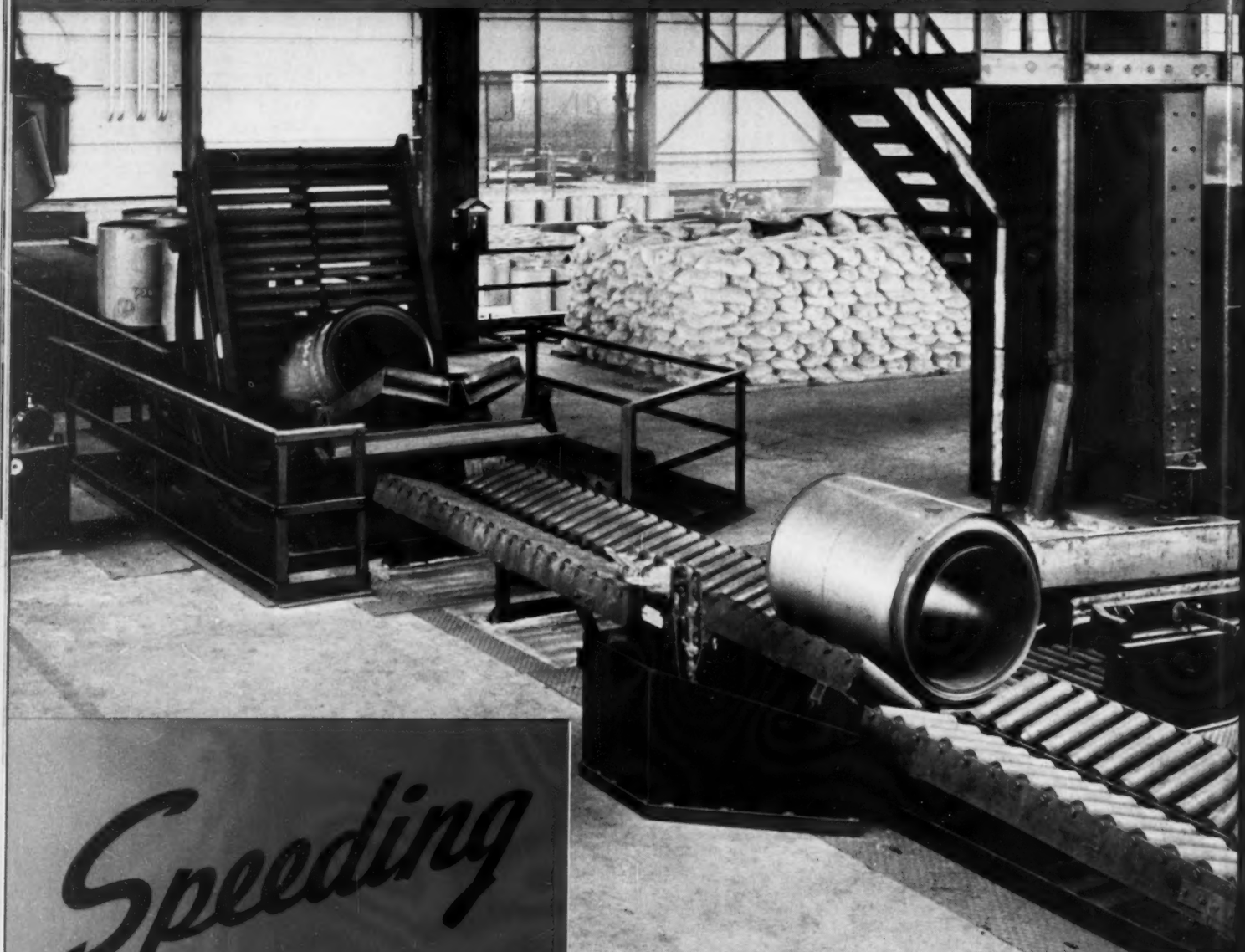

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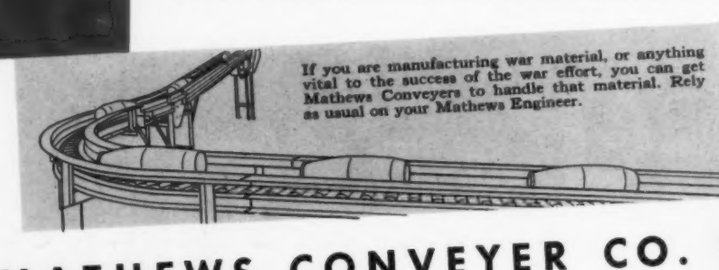

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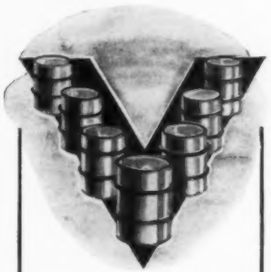

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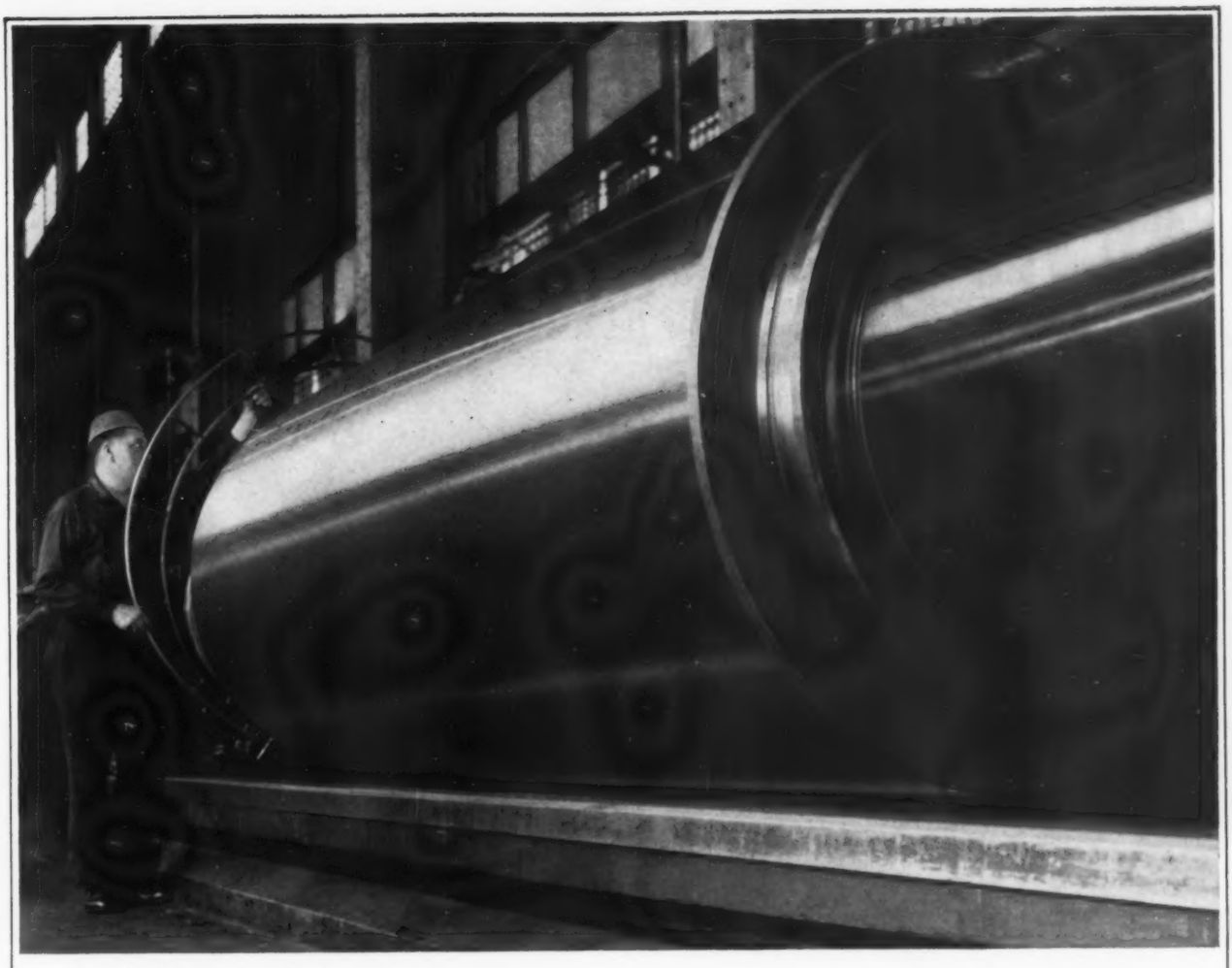

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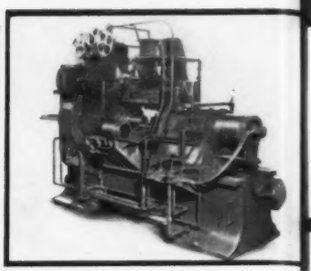

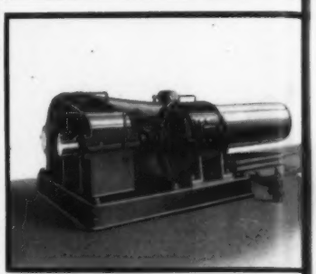

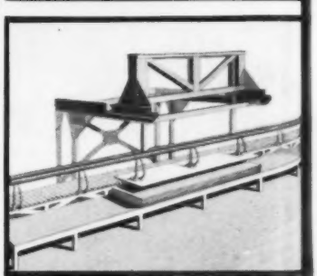

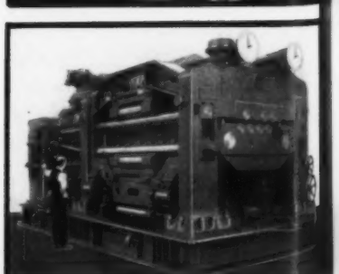

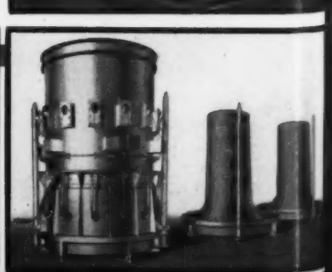

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Figure 1 — General view of sintering plant at Great Lakes Steel Corporation.

The SINTERING PLANT at GREAT LAKES STEEL CORPORATION

By Ernest Fuller

Engineering Department

GREAT LAKES STEEL CORPORATION

Ecorse, Michigan

▲ THE new sintering plant of the Great Lakes Steel Corporation is located on Zug Island, the site of the blast furnace plant — which lies off the north shore of the Detroit River.

Space available for a sintering plant on the island was very limited. It was necessary, therefore, to give considerable thought to its location and, in addition, to keep in mind the cost of handling raw materials required in the manufacture of sinter. The result was that the plant was located across and at one end of our No. 2 ore storage yard and adjacent to the ore and coke trestle. By extending our existing ore and coke trestle we are able to deliver the raw materials — dust, ore, coke breeze, mill scale, etc. — in railroad cars or the ore transfer car to a system of bins. The sinter and oversized raw materials are discharged into No. 2 ore storage yard where they are handled by the ore bridge and loaded into ore transfer cars and thence to the furnace bins. This location has proved to be highly satisfactory from an operating standpoint.

The sintering plant's conveying system is divided into two parts — one handling the raw materials from the trestle bins to the storage bins and the other handling the raw materials from the storage bins to the sintering machine. The raw materials are unloaded and

Figure 5 — View showing shuttle belt conveyor No. 4 which runs over the top of the storage bins. At the top is shown the vibrating screen and discharge chutes. At the left is the sintering machine.

Figure 6 — This illustration shows the vibrating screen, receiving and discharge chutes.

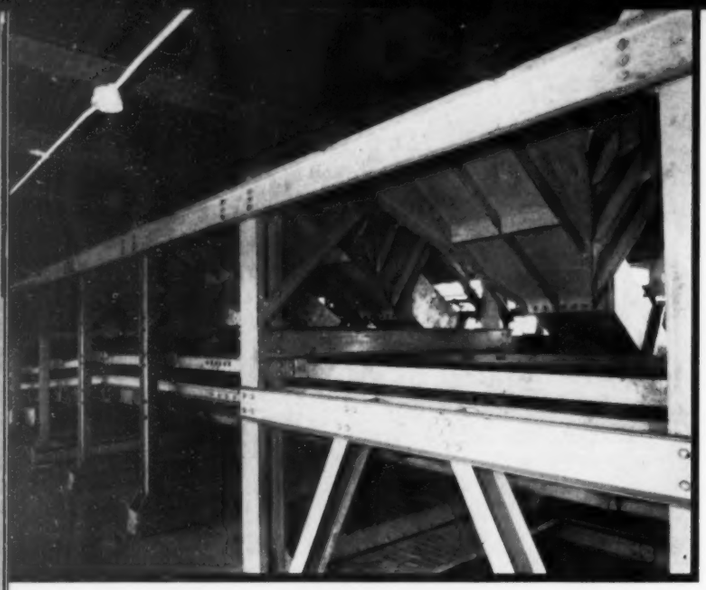

Figure 7 — View of the machine floor, showing windboxes, machine frame.

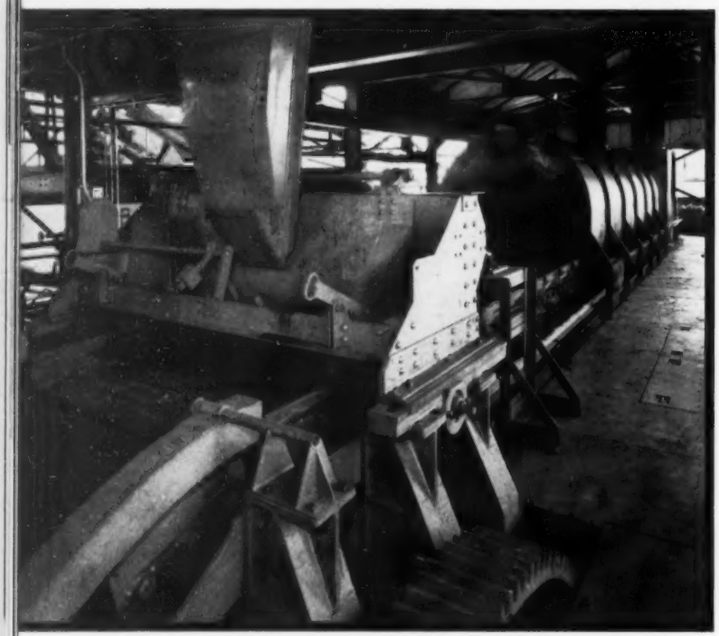

Figure 8 — View of sintering machine on working floor, showing the swinging spout, feeder and hood over the sintering machine.

Figure 9 — View showing the trestle receiving bins, rotary table feeders and belt conveyor.

conveyed to the storage bins during the 8 hr daylight shift, the storage bins being of sufficient capacity to supply the sintering machine for the remaining 16 hr.

The trestle receiving bins consist of four rectangular bins, each having a capacity of 2250 cu ft. Provisions have been made for the addition of two more bins. Each bin is equipped with a rotary feeder which delivers the material onto the belt conveyor. Each bin feeder is driven by a 5 hp, 1150 rpm, a-c motor through a herringbone speed reducer and a vertical type worm gear reducer driving the feeder. The feeder speed is 4.63 rpm. The materials are conveyed from the receiving bins to the vibrating screen by three 24 in. belt conveyors, No. 1, 2 and 3, having a capacity of 150 tons per hr at a speed of 206 fpm. The slope of belt conveyors No. 1 and 3 is 18 degrees.

The vibrating screen, over which all raw materials pass, is 48 in. wide by 120 in. long, with openings ½ in. wide by 5 in. long. The screen is driven by a 5 hp, 1200 rpm, a-c motor through a V-belt drive. The materials passing through the screen are conveyed by means of a chute to a 24 in. belt shuttle conveyor located over four circular storage bins and discharged into any of the four bins, each bin having a capacity of 3500 cu ft. The oversized material from the screen is delivered through the sintering plant to the ore storage yard by two 18 in. belt conveyors, No. 9 and 10, having a capacity of 100 tons per hr at a speed of 201 fpm.

The shuttle conveyor, conveyors No. 9 and 10, vibrating screen, conveyors No. 1, 2 and 3, and the receiving bin rotary feeders are electrically interlocked so that the failure or stoppage of any unit will shut down the preceding equipment. The trestle receiving bin rotary feeders are operated adjacent to the feeders. The remainder of the raw material feed system listed above is controlled from a control panel located on the shuttle conveyor floor.

Each of the screened material storage bins is equipped with a rotary feeder, the same as used on the receiving bins. The four rotary feeders are driven by one 20 hp, 850/1700 rpm, d-c motor through line shafting and gear reducers and clutches. The rotary feeders have a speed of 1.62 to 3.25 rpm.

The materials are conveyed from the storage bins to the pug mill by three 24 in. belt conveyors, No. 5, 6 and 7, having a capacity of 30 tons per hr at 100 fpm. Belt No. 6 receives from belt No. 11 the dust from the windbox collector main, dust collector, and drippings hoppers under the sintering machine. Belt No. 7 receives hot return fines from the return bin. These hot fines drop onto the belt carrying cold raw material, which has been spread over the width of the belt by means of a spreader, thereby protecting the rubber belting.

The pug mill is located in a separate building and is connected to the sintering building by means of conveyor galleries. The 24 in. x 9 ft 3 in. twin shaft pug mill is driven by a 40 hp, a-c motor through a V-belt drive. The water entering the pug mill is controlled by a manually-operated valve located at the sintering machine. Also located in the waterline is a solenoid valve connected to the pug mill motor circuit which will shut off the water supply when the pug mill goes down.

The pug mill discharges the material onto a 24 in

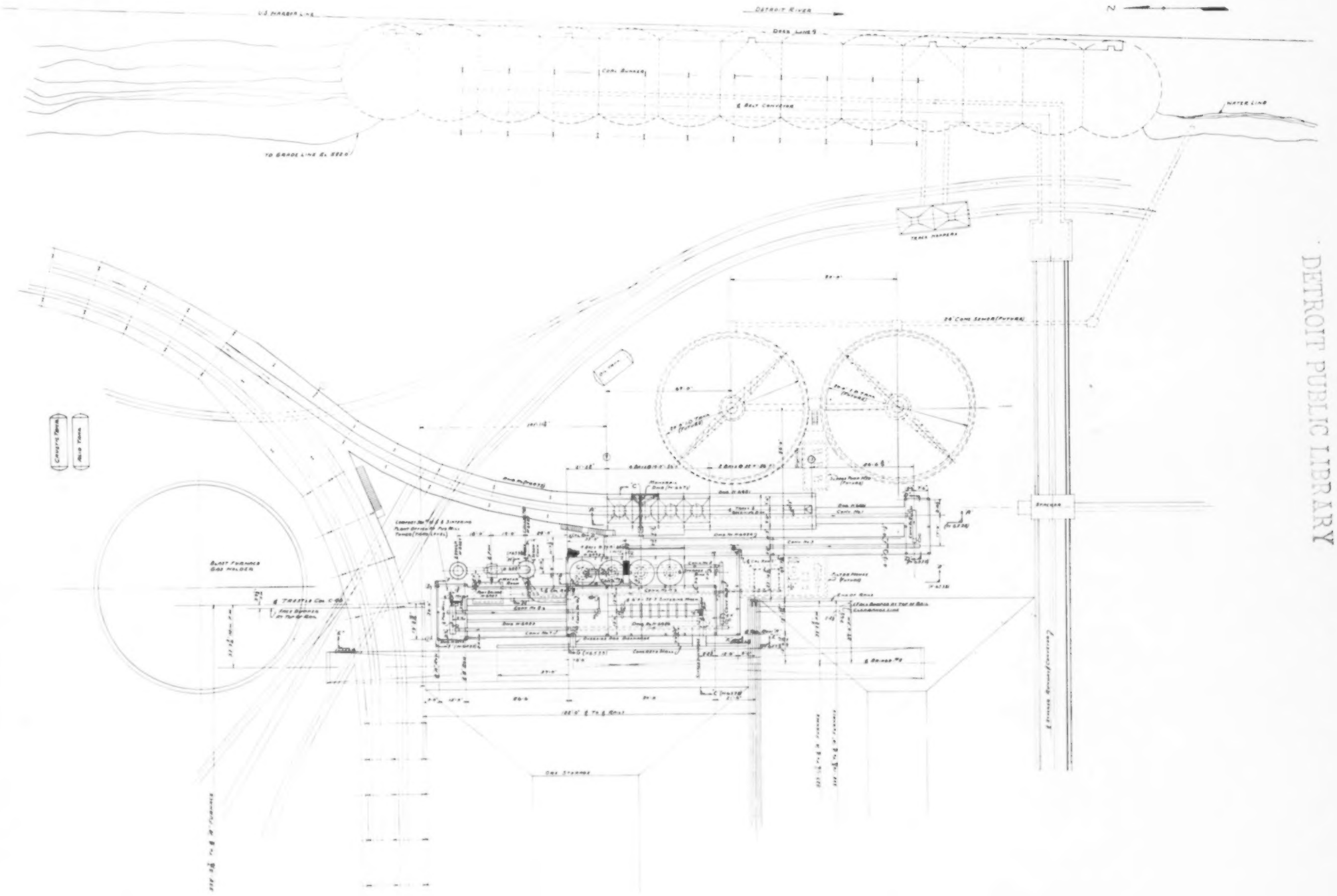

Figure 2 — General Plan of the sintering plant, showing trestle, conveyors, equipment and buildings.

Figure 3 — Cross sections of various buildings and equipment.

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Figure 3 — Cross sections of various buildings and equipment.

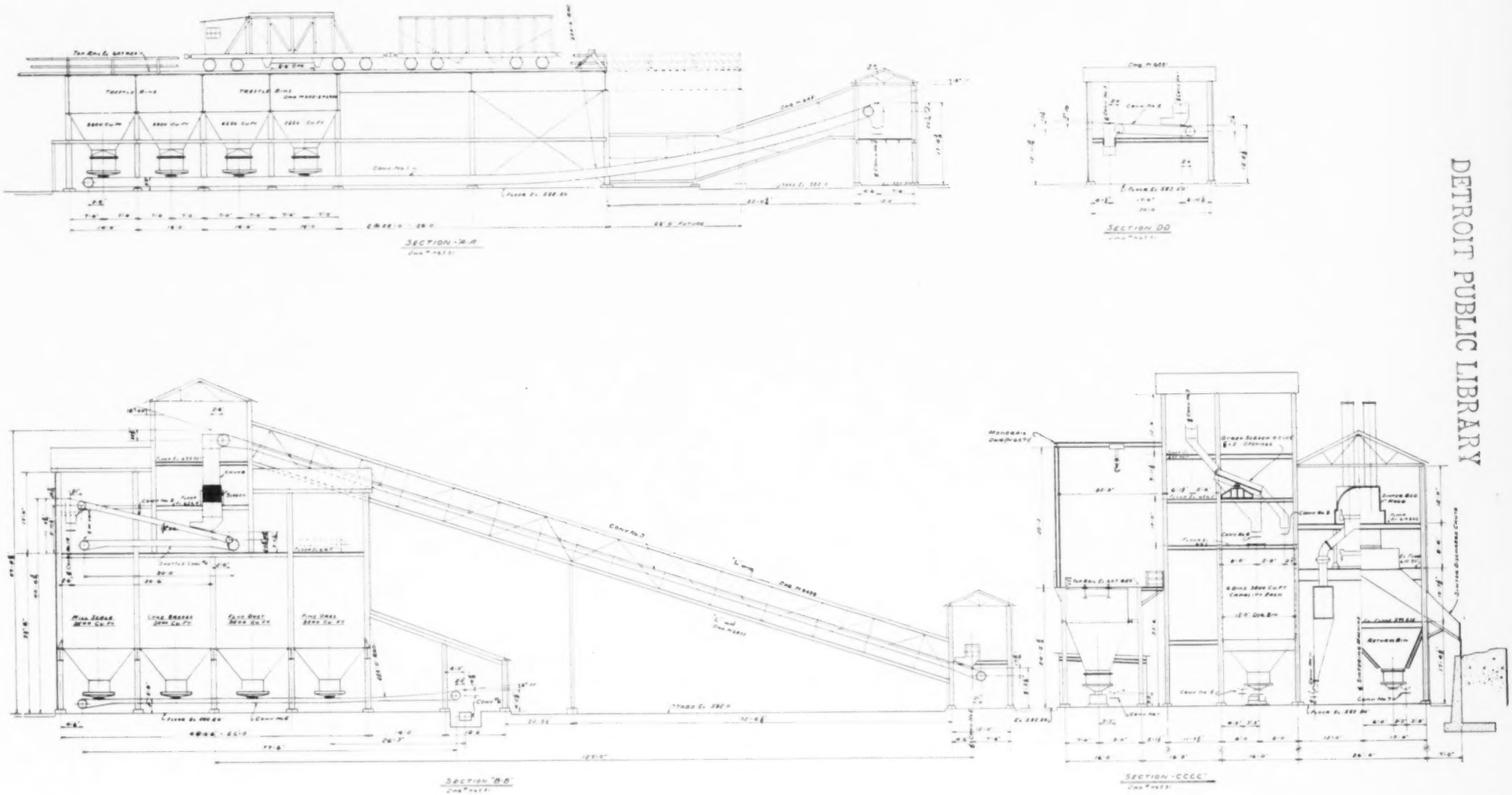

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Figure 4 — Cross sections through various buildings and equipment.

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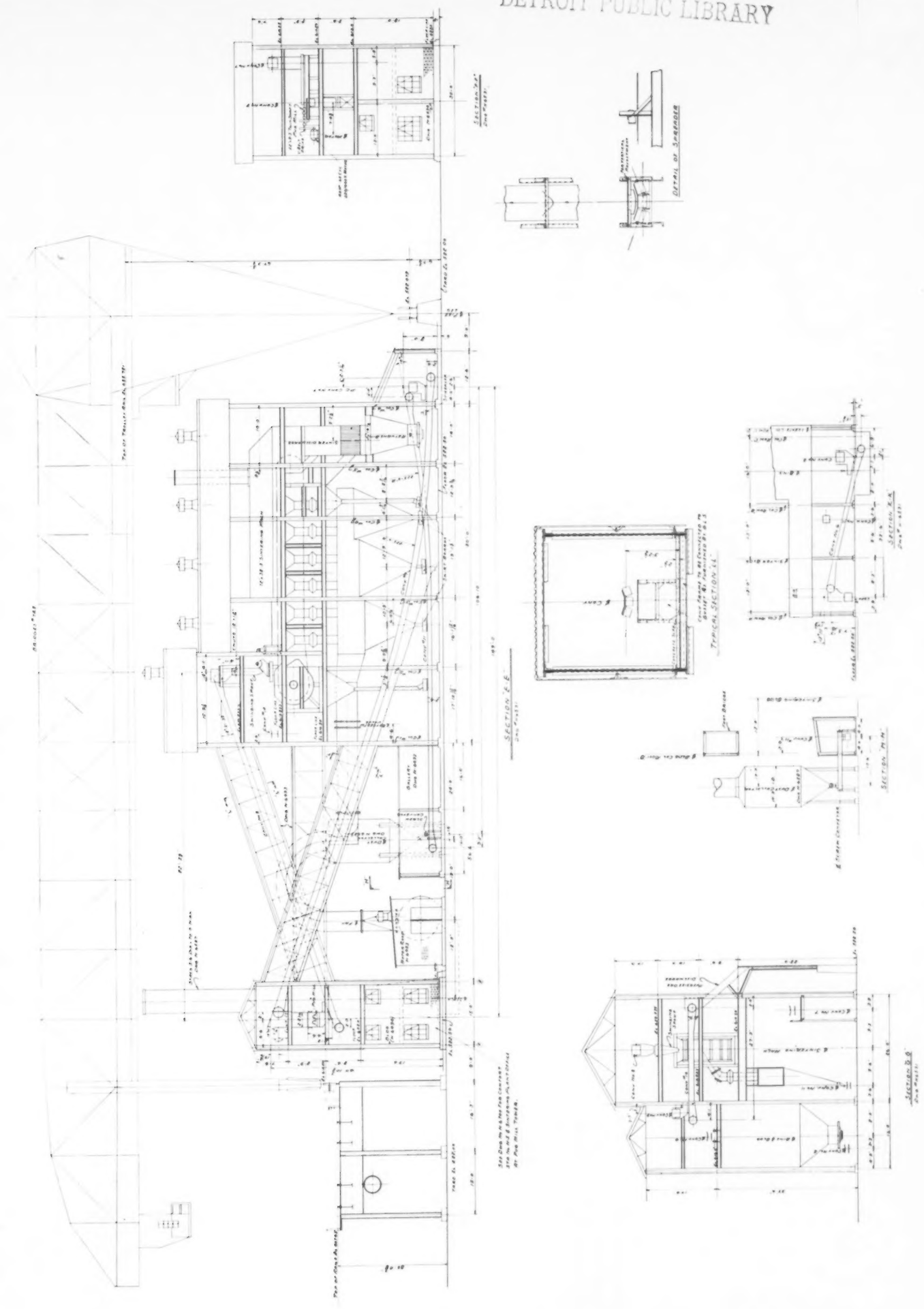


belt conveyor, having a capacity of 30 tons per hr at 100 fpm, which takes the material back to the sintering building to a hopper over the swinging spout which in turn spreads the material over the width of the sintering machine. The swinging spout, conveyor No. 8, pug mill, conveyor No. 7, hot fines return rotary feeder, conveyors No. 5 and 6, and the storage bin rotary feeders are electrically interlocked so that failure or stoppage of any unit will shut down the preceding units and prevent a pile-up of material.

The sintering machine is a continuous type and is 72 in. wide by 51 ft 1¾ in. from center of drive sprocket to center of discharge end curved track. The sintering machine has six windboxes and the distance over the windboxes is 38 ft 3 in. There are 61 pallets or grate bar buggies in all, each pallet frame being 2 ft 0 in. x 6 ft 0 in. and carrying six 8 in. by 36 in. grate bars, making a total of 12 sq ft per pallet. The sintering machine is driven by a 10 hp, 850/1700 rpm motor through a V-belt driven gear reducer and two reductions on the sintering machine gearing. The speed of the pallets is 2.13 to 4.26 fpm.

The material on the sintering machine grate bars is ignited as it passes under a set of ignition burners, designed by the Great Lakes Steel Corporation. The fuel used is coke oven gas delivered from the coke oven plant and air is furnished from a 16-oz pressure turbo-blower. Combustion on the sinter bed continues as it moves along over the windboxes until the entire depth is sintered when it reaches the discharge end of the machine.

The sintered material is discharged over a grizzle bar screen, which delivers by gravity the screened sinter into the end of the ore storage yard, where it is handled by the ore bridge and loaded into the ore transfer cars and delivered to the blast furnace bins. The sintered material passing through the grizzled bar screen is known as "hot return fines" and is delivered to a bricklined steel bin known as the "hot return fines bin." This bin is equipped with a rotary feeder, similar to those used on the storage bins, which delivers the material onto No. 7 belt as mentioned previously. The feeder is driven by a 5 hp, 850/1700 rpm motor through a herringbone reducer and a vertical type worm gear reducer driving the rotary feeder. The rotary feeder speed is 1.74 to 3.48 rpm.

As previously described, the material on the sintering machine is sintered as it passes over the windboxes. These windboxes, of which there are six, are connected to a collector main which has three hoppers in which dust is collected and dropped onto No. 11 belt. The collector main is connected to a centrifugal bricklined dust collector, 10 ft diameter by 15 ft high, located north of the sintering building. The dust is discharged into a screw conveyor, driven from the tail pulley of No. 11 conveyor and discharged onto No. 11 belt.

A 4 ft 6 in. diameter main connects the dust collector to the suction fan. This fan which is not covered by a building is a three-quarter housed bottom horizontal discharge with a double inlet connection and joined at the top to make one inlet connection.

The fan handles 54,000 cu ft of gas per minute of 300 F with 24 in. water gauge suction at the inlet to the fan when running at 885 rpm with 302 hp. The fan is

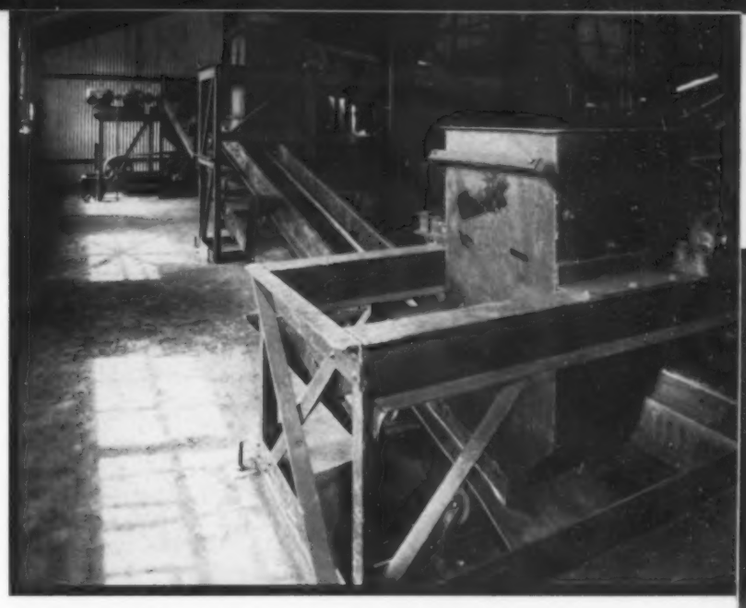


Figure 10 — View of belt conveyors No. 5, 6, 7 and 11 on the ground floor of sintering and bin building.

Figure 11 — View showing No. 7 belt conveyor, windbox, main, drippings hopper under sintering machine and belt conveyor No. 11.

Figure 12 — In the background are the four storage bins, rotary table feeders and belt conveyor No. 5. In the foreground is shown the windbox main and hoppers and belt conveyor No. 11.

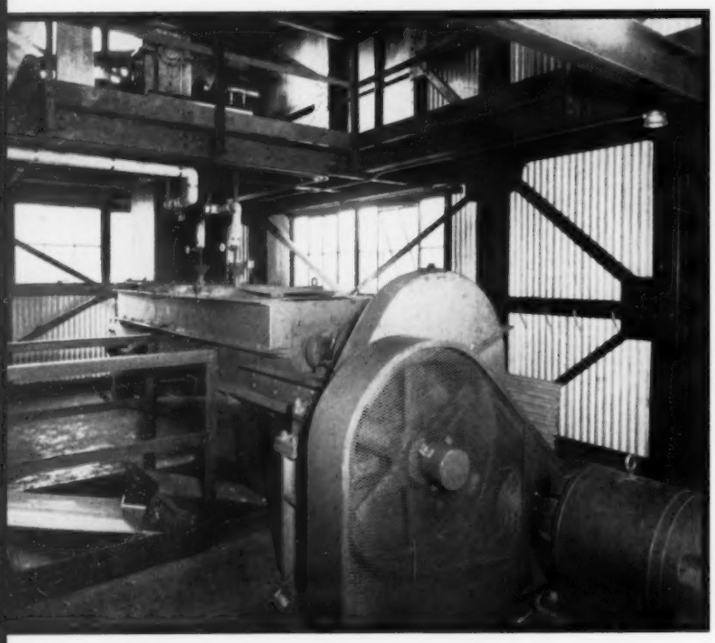


Figure 13 — View showing pug mill and drive and the receiving and discharge hoppers.

driven by a 350 hp, 950 rpm synchronous motor. The motor is located in a separate brick building furnished with a complete ventilating system. The fan is connected by an underground duct to an unlined 5 ft 6 in. diameter by 70 ft 0 in. high steel stack.

Three thermocouples located in the windboxes and one thermocouple in the fan inlet pipe connect to a four-point recorder, which records the temperature of the gases in the system. There are also connections in three windboxes and one connection in the inlet pipe to the fan which are connected to indicating manometers.

The storage bins and all of the equipment up to and including the sintering machine with its suction fan and ignition system are all controlled from one control panel located adjacent to the sintering machine.

The plant buildings of the trestle bin building, conveyor galleries, storage bin and sintering building, pug mill building, and fan motor room. The trestle bin building is located under the trestle and encloses the lower portion of the bins. This building is 16 ft 0 in. wide by 112 ft 0 in. long. The conveyor galleries are of structural steel construction with corrugated sheeting. The gallery floors are furnished with concrete precast slabs.

Figure 14 — View showing the trestle, trestle receiving bins, conveyor galleries No. 1, 2, and 3, and the bin building. At the extreme right is shown the sintering plant stack.

The storage bin building and sintering building are adjacent to each other. The storage bin building is 16 ft 0 in. wide by 66 ft 0 in. long by 50 ft 6 in. high and consists of the ground floor, bin feeder floor, and the vibrating screen floor. No partition wall exists between the bin building and the sintering building. The sintering building is 26 ft 0 in. wide by 80 ft 0 in. long by 57 ft 4 in. high and consists of the ground floor, machine floor, working floor, and the swinging spout floor.

The pug mill building is located 56 ft 6 in. north of the sintering building and is connected to the sintering building with two conveyor galleries and a footbridge. The pug mill building is 15 ft 0 in. wide by 30 ft 0 in. long by 44 ft 3 in. high. The building consists of four floors. The first floor houses a washroom and office; the second floor a shower and locker room; the third floor is the pug mill conveyor floor; and on the fourth floor is located the pug mill. This last floor is at the same elevation as the sintering building machine floor and is connected to it by a footbridge.

All buildings described above are of structural steel construction, covered with corrugated sheeting, except the first two floors of the pug mill building which house the offices and locker rooms, the walls of which are of brick construction. The buildings were designed for ample light and ventilation.

The plant was designed to produce 340 long tons of sinter per 24 hr. However, due to some unusual designs which were originated and incorporated by the Great Lakes Steel Corporation's engineering department, the plant has produced over 1000 long tons and is averaging 900 long tons per 24 hr. This production has only been possible by the close cooperation which exists between the operating and engineering departments. The production and quality of sinter during the ten months of its operation have been most gratifying.

At the present time we have under construction a wet flue dust recovery system, part of which is shown in the general plan and designated as a future installation.

The wet flue dust recovery system consists of four parts: (1) the collection of the gas washer and precipitator water; (2) pumps and pipe line to the thickeners; (3) the two 80 ft 0 in. double deck thickeners and sludge pumps; and (4) filtering equipment.

The amount of water to be handled is about 8600 gpm and contains about .3 per cent of flue dust. The amount of flue dust to be recovered will be approximately 150 tons per 24 hr.

The flue dust filter cake will be conveyed from the filter with a reversing belt conveyor to the No. 6 belt conveyor in the sintering plant when the sintering plant is operating. When the sintering plant is down, the material will be conveyed in the opposite direction onto another belt which will deliver the cake to the ore storage yard where it can be handled by the ore bridge. The wet flue dust recovery system is scheduled to go into operation about the middle of 1942.

Advanced Methods of

ARC WELDING

By E. W. P. Smith, Consulting Engineer
THE LINCOLN ELECTRIC CO.
Cleveland, Ohio

PRESENTED BEFORE A. I. S. E. ANNUAL CONVENTION, CLEVELAND, OHIO

▲ REDUCTION in time in the production of any product is of vital importance. Particularly is that true in the present national emergency or defense program, time at the present being all important. If weight reduction and cost reduction, with the obvious desirable results due to these, accompany a time reduction, then consideration and study of methods to produce these results are essential.

A reduction in time of production, weight and cost of structure by use of welding is such a familiar story that at times it is so taken for granted that no further effort or study is made to obtain the maximum results. These maximum results may be obtained by study and application of what may be termed advanced methods of welding and these advanced methods are relatively simple and easy to apply.

Such items as electrodes, size, current to be used, position of welding and effect on time of production by use of larger electrodes and higher currents, positioning to increase further the speed of production, adequate equipment properly applied, and selection of the most suitable steel for welding and fabrication are to be considered.

It is necessary that this be done carefully and completely as welding, a time and cost reducing process, is in competition with any and all other methods of fabrication and it must keep ahead. Just because outstanding results are being obtained now is no reason to become indifferent to progress.

Electrodes

Welding is defined as a localized consolidation of metals. A joining of parts which suitably assembled in relation to each other, results in the required part, or parts. The joint has a certain size and shape depending upon the design and fabrication requirements, and metal is deposited by the electrode in this joint.

The question then is to do this most effectively and in the least time.

Some basic conditions are readily developed. Metal deposited by good general purpose electrode requires electric power, at the arc. It is found that numerically the kw at the arc equals the rate of consumption of the electrode in lb per hr as indicated in Table I.

The usual deposition efficiency (ratio of weight of steel in bead to weight of electrode consumed) is 66⅔ per cent. Then the weight of the deposited metal di-

TABLE I

Power and Electrode Consumption

Electrode size, in.	Arc amperes	Arc volts	Kw	Consumption, lb per hr
1/8	110	24	2.64	2.60
5/32	130	25	3.25	3.30
3/16	150	26	3.90	3.95
1/4	250	30	7.50	7.50
5/16	325	34	11.10	10.70
3/8	425	38	16.10	16.20

NOTE — Electrode consumption rate, within normal operating ranges, is proportional to current.

vided by 66⅔ per cent equals the electrode consumed, equals the kw at the arc.

1.5 x lb of metal deposited = kw at arc

Weight of metal deposit (lb) = ⅔ kw at arc

Since arc amperes is a factor in kw, then an increase in arc amperes will result in a decrease in time (hr) which is increased speed of production. Obviously then the largest current which can be used is the most efficient in time reducing. Large electrodes, at high currents deposit metal at high speed.

How important this is may be illustrated by a rather general example, in reference to electrode use.

The Welding Engineer for May, 1941, gives electrode production or use for 1940 — 198,995,000 lb; for 1941 — 315,643,000 lb. This includes all sizes. Based on some general observations, about 80 per cent of this is ¼ in. and smaller. Taking the figure for 1941 this means 252,500,000 lb, ¼ in. and smaller. The same general observations indicated that ⅛ in. electrode is from 10-15 per cent of this amount, 5/32 in. electrode is from 30-35 per cent, 3/16 in. electrode is from 35-40 per cent, and ¼ in. electrode is from 15-20 per cent.

Averaging these percentages, approximately ⅛ in. would be 13 per cent, 5/32 in. would be 32 per cent, 3/16 in. would be 37 per cent, and ¼ in. would be 18 per cent, respectively, of a total of 252,500,000 lb.

On this basis then in 1941 the electrodes used will be as follows:

⅛ in.	13 per cent	32,825,000 lb
5/32 in.	32 per cent	80,800,000 lb
3/16 in.	37 per cent	93,425,000 lb
¼ in.	18 per cent	45,450,000 lb

On the usual 14 in. lengths there is a 2 in. stub end loss, about 15 per cent. This leaves for consumption only:

⅛ in. electrode	27,901,250 lb
5/32 in. electrode	68,680,000 lb
3/16 in. electrode	79,411,250 lb
¼ in. electrode	38,632,500 lb

On the basis of usual good practice, 50 per cent operating factor, the actual consumption rate would be:

⅛ in. electrode	1.3 lb per hr
5/32 in. electrode	1.65 lb per hr
3/16 in. electrode	1.95 lb per hr
¼ in. electrode	3.75 lb per hr

Dividing the pounds available for consumption by average rate gives man hours:

⅛ in. electrode	21,400,000 man hr
5/32 in. electrode	41,650,000 man hr
3/16 in. electrode	39,700,000 man hr
¼ in. electrode	10,300,000 man hr

Suppose that on 25, 50, 75 or 100 per cent of jobs now using given size electrode, the next larger size might be used, what would be the reduction in man hr?

A study of the figures in Table II reveals the great time reduction possible, merely by changing size of electrode just one size. It is not unreasonable to say that 75 per cent of the jobs done could be done with one size larger electrode, but say it is only 50 per cent. Then the time saving resulting in so doing would make available 8500 trained operators for other or additional work — and 8500 trained operators can do a lot of additional work.

Note also that in depositing metal in a joint, the fewer number of passes used, the lesser the distortion.

Positioning

A distinction must be made between position and positioning. Position is the location of the joint in reference to its making — as flat, vertical, horizontal, overhead. Positioning means placing the joint in a more favorable position for welding. It is of two general types, static and moving.

It is evident that higher speeds are obtained where joint is welded in the flat or downhand position — an increase of speed of 25-50 per cent and in some cases even 100 per cent may be obtained. The economic advantages are obvious. The designer must therefore give careful thought to layout and assembly so the shop may take full advantage of the highest speeds available. As an example the selection of a joint as a fillet may be so made as to obtain flat fillet in one case and overhead in another. Once the decision is made the shop has no alternative but to follow his design.

Where work may be moved, so positioning is possible, it may be so located that a joint is made in flat position — for example, a joint normally horizontal may be

TABLE II

Man Hours

Electrode, in.	Percentage of jobs done with next larger size electrode				
	0 per cent	25 per cent	50 per cent	75 per cent	100 per cent
⅛	21,400,000	20,330,000	19,170,000	18,060,000	16,900,000
5/32	41,650,000	39,785,000	37,770,000	36,155,000	34,340,000
3/16	39,700,000	35,030,000	30,450,000	25,875,000	21,200,000
¼	10,300,000	9,500,000	8,720,000	7,970,000	7,200,000
Total	113,050,000	104,645,000	96,110,000	88,060,000	79,640,000
Decrease	.....	8,405,000	16,940,000	24,990,000	33,410,000
Operators available	.....	4,200	8,470	12,495	16,700

made flat by turning the part 90 degrees, or it may be so arranged that the part is moving in relation to the arc. Either arc or part may be moving, as in case of girth seam in a tank, the tank is rotated and the entire girth seam made in the flat position. Speeds are correspondingly increased with resultant increased production.

Equipment

The welding unit or welding set must be considered as a whole. It must be thought of as a device for converting, for example, alternating current power of usual line supply into suitable power for efficient welding. It is not a usual motor generator set but a mechanism

E. W. P. SMITH

for producing, by means of electric power and electrode and suitable material, a welded joint at high speed and low cost. The first factor to be considered is the production of a welded joint. This appears so obvious, but is very frequently overlooked. It is necessary that the unit have proper controls so that the requirements of the arc may be accurately met, both as to timing and value of arc volts and arc amperes, and that the proper shape of volt-ampere curves for all jobs may be obtained. For a given arc-amperes, a high open circuit voltage produces different results than a much lower open circuit voltage. The fineness of control, that is, the number of volt ampere curves which may be obtained is very important, so the operator may be able to select the best setting for the job. With this is tied in the electrode used and the time.

Too much emphasis cannot be placed on this item or factor as it is one of those assumed to be either of minor importance or approximately the same in all equipment. An old generator is not as fast in production as a modern generator. This is self evident. Therefore, the selection of the best modern generator is vital if maximum production speeds are to be obtained.

Material

The use of welding involves the fabrication of materials into a completed part or whole. While a great many metals may be arc welded with results which are satisfactory to a degree, the selection of the material contributes greatly to the best possible results.

A practical example of this is an automatic job where full advantage could be taken of possible speeds due to good jigs, fixtures and fitup. A speed of 360 ft per hr was obtained. By changing the analysis of the steel, a speed of 600 ft per hr resulted. The cost of the material was no higher but the cost of the article was greatly reduced.

Even a rather general discussion of this subject would take considerable time but the above example indicates the practical results obtained and a few statements in reference to this subject will be indicative of the method to be followed.

Assuming that the physicals are satisfactory, then carbon is the most common element by which steel is chosen for a particular use.

It is not the only factor, and in some cases the usual steel specifications do not give the other elements, such as aluminum, silicon, vanadium, chromium, etc.

For example, steel of less than .15 per cent C has high gas absorption qualities and must therefore be carefully shielded. Silicon over .1 per cent may produce unsatisfactory welding unless other elements of deoxidizing material are present. The same is true of aluminum of more than .01 per cent.

Other conditions or elements may contribute to the weldability of steel or impair it. For example, sulphur (manganese or iron sulphide) may exist in form of layers. Porosity results (sulphur should be not over .05 per cent). Quite frequently sulphur in this form (segregated layers) is not disclosed by usual analysis. A deep etch of the cross section will disclose their presence.

For arc welding at high speeds for general purpose a steel of following analysis is recommended, assuming that mechanical or physical conditions are met:

	Per cent	Per cent
Carbon	.17	.15-.25 limits
Manganese	.45	.35-.60 limits
Silicon	.05	.07 max.
Sulphur	low	.05 max.
Phosphorous	low	.045 max.
Aluminum	Not over 2 oz per ton added unless semi-killed with silicon in which case aluminum should be as low as practical, with from .04-.07 per cent silicon.	

Conditions or requirements, other than welding, as corrosion resistance, hardness, very high ultimate, may enter into selection of material, but the analysis necessary should always be considered in reference to welding.

All of the items or factors mentioned above are of such a general or broad nature that they may be applied to either manual or automatic arc welding. The advantage of automatic welding as high speed production of a uniform product usually leads to consideration of these factors, but in manual welding they are occasionally overlooked or disregarded. It is necessary, if high speed, high quality arc welded products are to be obtained, that larger electrodes be used with the position of the joint, either inherent or positioned, such as to permit highest speed, the whole made possible by adequate modern equipment which will, by means of fineness and accuracy of control, permit proper setting of the machine to meet any and all requirements of the arc. The use of good weldable steel is essential for production at high speed and low cost. Time saving is particularly a most desirable objective in this day of emergency and national defense.

DISCUSSION

A. W. STEED, Maintenance Superintendent, American Rolling Mills Company, Middletown, Ohio

A. B. WHITE, Research Engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

J. S. McKEIGHAN, Sales Engineer, Lincoln Electric Company, Cleveland, Ohio

E. W. P. SMITH, Consulting Engineer, Lincoln Electric Company, Cleveland, Ohio

A. W. STEED: Mr. Smith has just given us a very worth while paper, and one remark that he made impressed me very forcibly. He stated that if the rod normally used in welding was increased to the next larger size, 8500 operators could be released for other work. With the National emergency facing us the above possibility should be given serious consideration.

A. B. WHITE: In these days of scarcity of materials, equipment and trained men, too much importance cannot be placed on making the best use of the facilities available. This timely paper clearly indicates the potential savings in an important phase of our national defense program and handles the problem in a very interesting manner. The author is to be congratulated.

The article suggests a way not only of making a small army of operators available but also of freeing large quantities of welding equipment for other jobs, thus relieving the industries producing machine tools and priorities materials.

However, each job must be considered as a particular problem and it must be determined whether or not the savings in time are true or only apparent, or if the saving are obtained by the sacrifice of some more important factor. For example, a large percentage of the welding done consists of single-pass fillets. The art has advanced so that the largest electrodes and greatest currents practical are in use in most cases. Further increases in electrode sizes (with their correspondingly higher currents) may cause any one or a combination of the following results:

1. For the same size of weld, an increase in length proportional to the electrode consumption may be obtained but it may be accompanied by an increase in undercutting and porosity and a decrease in the all-important root penetration.

2. Reducing the welding speed will reduce the tendency towards undercutting and poor root penetration but this practice defeats the advantages of using larger electrodes.

3. Larger electrodes require higher currents, and in the majority of cases a generator already operating above rated capacity must be replaced with one of higher capacity. The result is a higher plant overhead cost and additional orders on already overloaded industries.

4. For a given set of conditions, the use of larger electrodes and higher welding current often results in increased grain size and decreased ductility.

The above points are also true for most grooved welds as well as for fillet welds. It is true that in multiple-pass welds, decreasing the number of passes decreases distortion up to a certain point. Beyond that point the excessive heating of the work itself resulting from increased arc heats produces another source of distortion. Decreasing the number of passes also tends to decrease grain refinement and ductility.

It is well known that the quality and analysis of the work material will affect welding speeds, particularly with carbon arc welding, upon which the author's examples and recommendations are evidently based, and with which this writer has had some experience. Modern heavy coated electrodes, however, will weld a comparatively wide range of materials with almost equal facility. Fortunately so, for steels having special analyses are very difficult to obtain from an industry doing everything possible to supply defense needs. In general, however, the amount of weld metal is small compared to the whole structure and the savings do not justify premium prices for special analysis and quality in structural material.

The proposed use of larger diameter electrodes is one of several things that can be done to speed up welding. Other ways are:

1. Frequently the width of the bevel on the joint may be reduced, with a proportionate reduction in deposited metal.
2. It is sometimes possible to redesign the product to make more efficient use of welds or even to eliminate much unnecessary welding.
3. In many cases, electrodes in use at present may be replaced with electrodes having a higher melting rate, thereby decreasing welding time.
4. As with changes in welding position, other conditions may be changed to reduce welding time and deposit. For example, where arc blow is troublesome, alternating welding current may be used to reduce the blow, improve the weld quality and reduce the required weld metal deposition time.
5. In a few cases, very great savings in time may be made by changing to another process, such as flash or resistance welding.

A. W. STEED: At one of our ininspections a housing on the slabbing mill was found to be cracked approximately half way through. At first it looked as though a thermit weld was the only practical way to repair. Due to the time required to dismantle the mill for a thermit weld, it was decided that there was a reasonable chance that it could be welded electrically. The casting was scarfed out on the cracked side and a bridge welded at the center of the section to hold the alignment, then the opposite side was scarfed out so that both sides were the same. Welding was carried on from both sides simultaneously, each head being thoroughly cleaned, and peened to relieve stresses. This procedure was carried out to the completion of the weld and the housing machined in place. This equipment

(*Please turn to page 60*)

COPPERWELD STEEL COMPANY

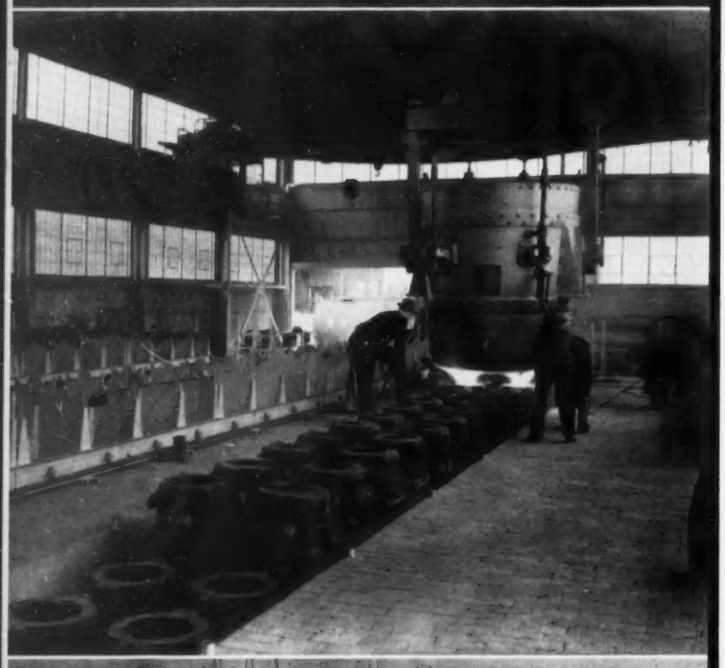
Steel, in a variety of high quality carbon and alloy grades, is produced entirely in six electric arc furnaces.

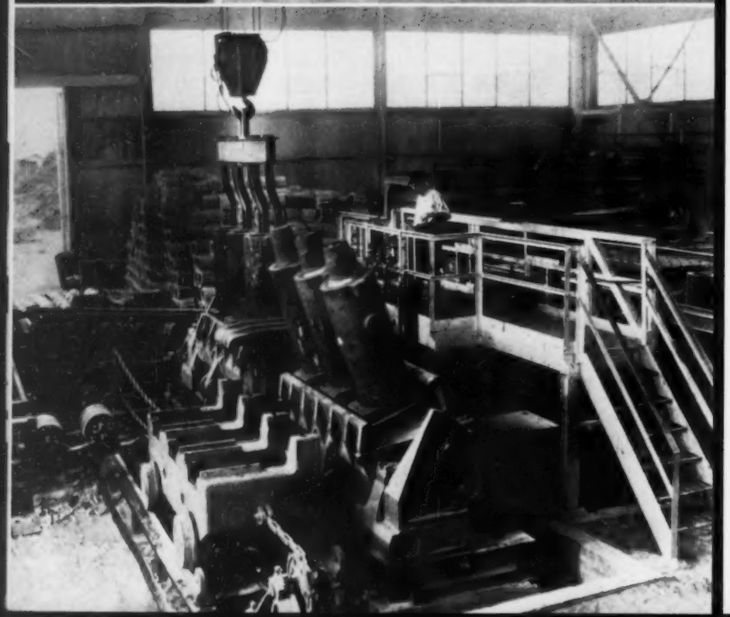
By T. J. Ess, with personnel photographs by J. R. Scott

▲ FOR the past thirty years, the Copperweld Steel Company has conducted operations at its plant in eastern Pennsylvania, the principal product being copper-covered steel in the form of rods, wire and wire products. Due to the fact that the dual material, as formed by the company's molten welding process, can be hot rolled, cold-drawn, forged, bent or twisted without separating the two metals, the company has enjoyed well-merited success — a success which has been carried over into an expansion into the field of high grade alloy steels. Just two years ago, the Copperweld Steel Company began operations in a new steel plant in the eastern part of Ohio. This plant was designed specifically to produce steel of high quality, and is turning out carbon and alloy tool steels, stainless steel, nitralloy stock, aircraft steels, SAE alloy types, etc. A great part of the success of the new venture must be attributed to the experienced personnel with which the plant is staffed, much of the supervisory staff as well as the operating force having been drawn from plants wherein the country's alloy steel production was developed.

Electric Furnaces

Steel is produced only in electric arc furnaces. The melt shop is 78 ft x 700 ft, and contains six furnaces. Two furnaces have 16 ft diameter shells, one has a 17 ft shell, and the remaining three are 11 ft in diameter. The three large furnaces are heavily powered, with a 12,000 kva transformer on each, while two 5000 kva and one 2500 kva transformers are provided for the three small furnaces. All transformers are installed in a transformer vault running along one side of the melt shop. The transformers have a range of ten secondary voltages, ranging 270-110 volts, and affording a marked degree of flexibility over the range of operation from rapid melting of light scrap to the reduced voltages of the refining phase. A range of reactance values, adjustable in equal increments, is built into each transformer, so that reactance may be changed to suit the power system, from minimum impedence of the circuit up. Flexible cables, water-cooled and rubber-protected, carry the power to the graphite electrodes, which are 18 in. in diameter on the three large furnaces and 17 in. in diameter on the three small units. All of the furnaces are top-charge units except two of the small units. The lifting and swinging motions of the roofs are actuated by heavy oil hydraulic lifting rams which include another oil hydraulic cylinder for the transverse swinging motion. A single lever actuates both motions, the two motions being interlocked so that the swing cannot be made before the lift is complete. An automatic decelerating device prevents bumping at both ends of the





swing, which requires only 30 sec for each direction. Four-point suspension of the roof has done much to eliminate excessive stresses on the roof refractories.

The furnace bottoms are rammed in, of a prepared magnesite refractory which air-sets to a dense monolithic mass, and, under operating temperatures, develops high resistance to slag and metal penetration, chemical attack, and erosion.

Paralleling, and adjacent to the melt shop is a stock-house 80 ft x 330 ft, served by two 10-ton cranes and containing six concrete bins, each 25 ft x 42 ft. Incoming scrap is carefully sorted into these bins according to grade and analysis. Nine smaller bins hold crop ends from the mills in the plant. Running the length of the stock house is a loading track upon which travels an electric transfer car carrying two charging buckets. These buckets are cylindrical, with six hinged segments forming the bottom and held in closed position by several twist of rope. After the buckets have been

The large furnaces are of top-charge design, using cylindrical charging buckets with segmental drop bottoms.

Pouring aisles are arranged for a double row of ingot moulds on stationary stools. Two ingots are poured simultaneously.

Ingot moulds are carried by crane to a stripper of unusual design, from which the ingots are taken to the heating furnaces over roller conveyors.

filled and weighed on the stock house track scale, they are moved into the melt shop. An overhead crane then suspends each bucket above the furnace, the rope is burnt away, and the scrap drops into the furnace.

Limestone and dolomite are stored in elevated bins, so that the material can be chuted into steel trays and delivered to the furnaces by overhead crane. Six steel

D. G. BAXTER
General Superintendent

S. D. WILLIAMS
Executive Vice-President

bins afford storage for the various materials used as furnace or ladle additions.

Thus, the top-charge furnaces, stated to be the largest of this type in the country, can be charged in as little as ten min. Due to the high electrical input available, the melt-down period is usually completed in about two hr. The total time of heat, tap to tap, averages 7½-8½ hr in the large furnaces and 6½-7½ hr in the small furnaces. Heats average about 50 tons in the 17 ft furnace, 40 tons in the 16 ft furnaces, and 10 tons in the 11 ft furnaces. The large furnaces consume about 530 kw-hr and 13 lb of graphite electrodes per net ton of ingots, with the small units using 760 kw-hr and 26 lb of electrodes per ton. Metal-cased magnesite brick are used for furnace construction, the linings lasting for more than 200 heats. Roofs are rebuilt on accurate forms in relining pits, where roofs are also stored until needed.

Steel racks are provided for storing the stock of graphite electrodes to be used by the furnaces. Also, three steel holders are provided in which to place the electrodes removed from a furnace while replacing a roof. When not in use, ladles are placed on stands along one side of the shop, where four natural gas burners are provided for warming up the ladles. Ladles are relined in a pit located adjacent to the roof rebuilding forms. Conveniently nearby is a gas-fired oven for drying stopper rods.

Heats are tapped into ladles equipped with double stopper mechanism, allowing the simultaneous pouring of two ingots. The full ladle is transferred to the pouring stations where there are six aisles 75 ft long, each wide enough to accommodate two rows of ingot moulds. Mould stools, each holding six moulds, rest on heavy I-beams supported by concrete piers. Between the aisles are platforms, on which are racks for holding the hot tops. Natural gas burners are built into these racks and are used to dry out and heat the hot tops, which are then placed on the moulds before teeming. Ingot sizes in common use are a 15 in. fluted round, and 17 and 18 in. round-cornered square fluted ingots, all big-end up. Moulds are sprayed with tar before each use, and the speed and temperature of teeming is carefully controlled.

Ingot Stripper

After the ingots have soldified in the moulds, an overhead crane equipped with a multiple hook picks up three moulds and carries them to a stripper of

J. P. SMITH
Chief Engineer

W. A. DYE
Superintendent of Melt Shop

A. E. WANTZ
Superintendent, Finishing Department

W. J. BUECHLING
Chief Metallurgist

unusual design. This unit consists of a 100 ton horizontal pusher ram placed between two tilting machines, and a movable car. The ram and the tilting machines operate on oil hydraulic power, while the car is moved through a chain pull by an electric motor. The three moulds are placed on one of the tilting machines, automatically clamped to it, tilted through 90 deg, and deposited in a horizontal position on the car. The car then moves the moulds past the stripper head where each mould in turn engages the stripper head, while the ram ejects the ingot from the mould. When the three ingots have been stripped, the moulds are gripped by the second tilting machine, restored to a vertical position, and returned by overhead crane to the pouring aisle. Meanwhile, another trio of moulds has been placed on the first tilting machine, ready for repetition of the cycle. Four cranes, one of 50/20 tons, one of 50/15 tons, one of 35/10 tons, and one of 10/5 tons, are installed in the melt shop.

Ingots are heated in in-and-out side door furnaces fired with low pressure natural gas.

Ingot Heating Furnaces

As an ingot is ejected from its mould, it is received upon a 180 ft underground conveyor table over which it is carried to the furnace building. Here there are six in-and-out side door heating furnaces, each containing two separate chambers. Each chamber is 18 ft long x 8 ft wide, and approximately 9 ft high, and is fired with natural gas through five low pressure burners spaced on 3 ft 7½ in. centers across the back wall. Luminous flames are directed under the roof toward the front of the furnace, then flow down and back along the hearth through the action of six flues spaced along the bottom of the back wall in each chamber. These flues rise into a breeching which leads to a 36 in. stack for each furnace. The furnace roof is a sprung arch 9 in. thick, topped by 2½ in. of insulation. Sidewalls are 1 ft 10½ in. thick plus 4½ in. of insulation. Two large doors, 5 ft high x 7 ft 6 in. wide form the front of each chamber. Ingots are placed in these furnaces in an almost vertical position, leaning against the back wall, and are heated by the gases circulating around them. The furnaces are equipped with automatic temperature controls. Two overhead charging machines, with peel and tong grip, handle ingots into and out of the furnaces.

Blooming and Billet Mills

Heated ingots from these furnaces are placed upon the blooming mill approach table and carried to the mill, a 29 in. three-high unit driven at 40 rpm through

CHARLES MORGAN
Superintendent of Maintenance

D. L. IMMEL
Superintendent, Rolling Mills

a gear ratio of 9:1 by a 1200 hp, 360 rpm, 2300 volt wound rotor motor. Tilting tables and manipulators are installed on each side of the mill, the former pneumatically operated, the latter electrically. This mill operates at an average rate of about 26 net tons, finished weight, per hr.

A down-cut cropping shear, for sections up to a maximum of 10 in. x 10 in., is located about 70 ft from the blooming mill, and a kick-off and cradle is placed about 40 ft farther along.

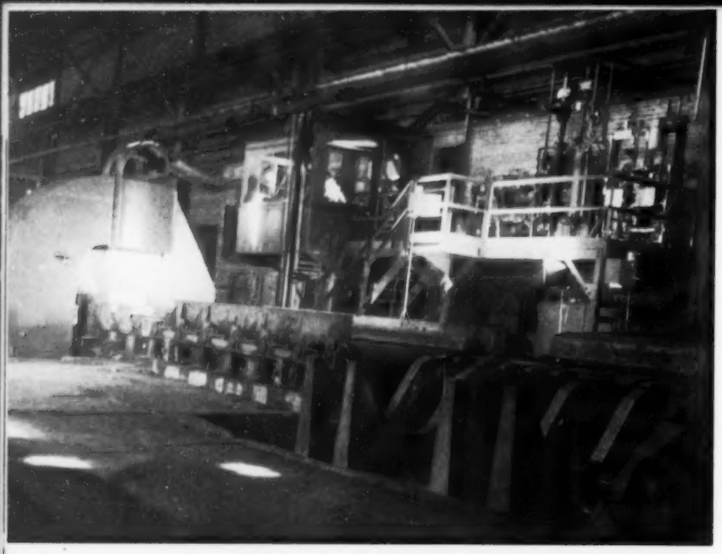
About 236 ft from, and in line with, the bloomer is a 24 in. three-high billet mill, with tilting tables front and rear. This mill is driven at 56 rpm through a 9:1 reduction by a 1200 hp, 505 rpm, 2300 volt would rotor motor. Product from this mill ranges 4½ in. to 7 in. diameter, and similar sections in squares. Following this mill is an up-cut shear and a 60 in. hot saw, closely followed by a kick-off and cradle. Billets may be kicked off here, or may be passed over a cooling bed transfer about 22 ft x 56 ft, according to the cooling schedule required by the products. Two holding pits are provided near each of the two kick-offs in the mill line, and thirteen holding pits are located near the cooling bed, which lies in the billet storage building.

The 29 in. and 24 in. mills are housed in a single building 71 ft wide x 528 ft long, served by one 25/10 ton crane and one 10 ton crane. The mill layout is such that material may be rolled direct through both mills with one heating, or, should the product require, ingots may be broken down on the bloomer, removed at the first kick-off, conditioned, and returned to the heating furnaces for subsequent rolling on the 24 in. mill.

The two main drive motors of the 29 in. and 24 in. mills are located in a motor room formed by a 40 ft x 264 ft extension along the side of the mill building, and served by a 15 ton crane. The motor room also contains four air compressors supplying plant requirements, and motor-generator sets supplying d-c power for plant auxiliaries.

A hot scarfing machine has been recently installed in the mill line, desurfacing four sides of the bloom simultaneously. The machine will operate on blooms from 3 in. to 10 in. square, and removes about $\frac{1}{32}$ in. from each face at a material speed of about 170 fpm. By passing the material through at higher or lower speeds, thinner or thicker layers may be removed. Oxygen and acetylene are supplied to the machine from central

The blooming mill is a three-high 29 in. stand driven at 40 rpm by a 1200 hp motor.



General view of hot scarfing machine with smoke removal system, installed in the blooming mill line.

generating plants which also supply other plant usages. The desurfacer is used successfully for the conditioning of the various alloy grades of steel produced in the plant. This machine employes adjustable, multiple-nozzle fully protected blowpipe units mounted on counter-balanced carrier plates. The nozzle protecting shoes are held with a light contact against the four sides of the bloom to insure precision of surface removal, and a special full floating action of the machine provides for accurate scarfing regardless of any ordinary vertical or horizontal camber of the bloom.

The nozzles of the four units, designed to operate in unison to leave essentially flat, ridgeless surfaces, are mounted in distribution headers. These four units are adjustable to provide for the complete coverage of any section rolled by the bloomer, and the nozzles are adequately cooled by a closed water circulating system. The complete carrier plate units for the machine are easily removed or replaced to facilitate maintenance.

The machine is mounted on a motor-driven carriage which also carries the control valve panels and an idler roll to support the bloom during desurfacing. The machine carriage is installed transversely to the roll table on rails and may be run in or out of the line in a few seconds. Positive passage of the steel at controlled speeds through the machine is obtained by means of special pinch rolls.

All electrical controls and gas control valves are mounted on a table in the operator's pulpit, located in an elevated position at one side of the table to provide good vision of the steel as it approaches the machine. Gas control equipment is installed adjacent to the control pulpit on the same balcony.

An efficient smoke removal system collects and discharges all smoke and volatile material arising from the thermo-chemical reaction and the resultant slag is transferred to a collection pit by means of a special chute and high pressure water jets.

Additional billet conditioning is performed in the pickling and chipping building, 80 ft x 675 ft, and served by one 15 ton and two 10 ton cranes. Two 7 ft x 22 ft pickling tanks, of dual brick construction, with the inner course laid up in a resin cement and the outer course in a sulphur cement, are installed, as well as a battery of swing grinders, five universal cold saws, chipping beds, etc. This building extends across the ends of the blooming mill building and the bar mill building, making a good layout for the progressive flow of material through the successive processes.

Bar Mills

Further conversion of billets into bars and rods is effected in the bar mills, which are located in a building 80 ft x 925 ft, containing one 15-ton and two 10-ton cranes. Billets to be rolled in these mills are heated in a single continuous end-charge, side-discharge furnace. Hearth dimensions are 21 ft width x 40 ft length, and the furnace is sectionalized into several zones. The steel first passes through a low-roofed preheating zone and into a heating zone about 12 ft long and 5½ ft high. Another low zone 7½ ft long is followed by another firing zone about 8 ft long. Ten low pressure burners are spaced across the first heating zone and six burners across the second heating zone, all burning natural gas and directed in the same direction as the movement of steel through the furnace. The furnace roof is of flat, suspended arch construction, 9 in. thick, and topped by 2½ in. of insulation. The billets ride through the furnace on six dry skids, under the action of electrically operated pushers. The charging table of this furnace extends over into the billet storage.

A dividing shear is located in the mill table at the furnace exit, and the billets pass on to the 18 in. mill, composed of two 3-high stands and one 2-high stand placed side by side, and driven at 91 rpm through a gear reduction of 4.4:1 ratio by a 2000 hp, 400 rpm, 600 volt d-c motor. The three pass lines are provided with the necessary tables and cross transfers. After receiving the final pass in the 2-high stand the bar moves on to a 42 in. hot saw located about 125 ft from the mill, and then to a cradle or over a 70 ft hot bed. The 18 in. mill produces rounds 1 in. to 4¼ in. in diameter (or equal square sections) at a rate of 12-19 tons per hr.

Two bar mills, 18 in. and 12 in. in size and operating under variable voltage control, provide re-rolling facilities.

The first stand of the 18 in. mill is also used as a breakdown unit for the 12 in. mill, 102 ft distant. The latter is a looping mill consisting of five 2-high stands placed side by side and driven directly by a 1500 hp, 300 rpm, 600 volt, d-c motor. From this mill, bars are delivered past a rotary flying shear to a cooling bed 205 ft long, which is followed by a shear and cradle. This mill produces ½ in.-1¼ in. rounds (or equal square sections) at a rate of 3-8 tons per hr.

Two holding pits are installed near the 18 in. mill kick-off, and four pits are located near the 12 in. mill cradle.

A major portion of the plant production comes from the 18 in. and 12 in. bar mills, the balance being finished from the 24 in. mill. Both the 18 in. mill and the 12 in. mill are operated under variable voltage control, each drive motor receiving power from a motor-generator set rated at 1500 kw, 600 volt, d-c, and driven at 360 rpm by a 2100 hp, 2300 volt synchronous motor.

Finishing Department

Paralleling the bar mill building, and adjacent to it, is the finishing department, a building 80 ft x 925 ft containing three 10-ton cranes and a 10-ton gantry crane of 39 ft span. Here are installed 17 gas-fired car-type furnaces for hardening, annealing, and drawing. These furnaces are of two sizes, 6 ft x 33 ft 6 in., and 6 ft x 24 ft. Three oil quench tanks and one water quench tank, as well as loading racks, are installed at convenient points along the row of furnace pull-out tracks, over which the previously mentioned gantry crane operates. Additional finishing equipment installed includes five turning machines, three cut-off machines, five bar straightening machines, scales, chipping bed, etc. Some additional finishing equipment installed in the bar mill building includes one annealing furnace, four saws, a bar centering machine, a gag press, etc., while five centerless grinders are located in a smaller building adjacent to the finishing department. A separate small building houses bar pickling tanks. A number of transfers are provided for stock movement from one building bay to another.

Numerous gas-fired car type furnaces are installed in the finishing department for hardening, annealing and drawing bar stock.

Miscellaneous

Electric power for the plant is obtained at 23,000 volts from the nearby substation of the utility serving the district. This voltage is carried directly to the transformers of the electric furnaces, and to two 6000 kva transformer banks which furnish 2300 volt power for the remaining plant power. D-c power for plant auxiliaries is provided by four 750 kw, 250 volt motor generator sets, each driven by a 1080 hp, 2300 volt, 900 rpm synchronous motor.

To maintain a good power factor on the plant load, a synchronous converter rated at 15,000 kva, 6900 volts, 900 rpm, is installed. The plant operates on a 15 min. demand of about 24,000 kva, and with full operation consumes about 11,000,000 kw-hr per month.

Steam for heating pickling tanks, plant heating, etc. is supplied from three 240 hp boilers.

Plant service water is taken from a river, on the bank of which is a pump house containing three motor-driven centrifugal pumps, two of 2100 gpm and one of 2500 gpm. A stand pipe, 18 ft in diameter and 85 ft high, operates on the system to maintain pressure and act as storage. Plant consumption averages about 4000 gpm. Drinking water is pumped from two deep wells, each producing about 100 gpm. A connection is also maintained with the city water system as a standby.

Natural gas forms the entire normal fuel supply of the plant, being supplied to the plant at a pressure of 20 psi, and reduced down to suitably low pressures at the furnaces. An auxiliary fuel oil system has been installed as a standby for possible periods of gas shortage.

The great amount of testing required by the special grades of product made in the plant is performed in complete, modern metallurgical and chemical laboratories, centrally located. The chemical laboratory and the melt shop are connected with a pneumatic carrier system for samples, and a telautograph system for speedy written communication.

New Expansion

Just nearing completion are a series of additions to the plant, made under government financing to meet great increases in demands for production. The extensions include two electric furnaces duplicating the 16 ft furnaces previously described. Extensions were also made to the stock house, the pouring aisles were rearranged, and a second stripping unit was installed. Two more ingot heating furnaces were installed, duplicating those originally installed. A new billet shed parallels the original building, and the latter has been extended to run past the ends of four new buildings in which are housed a new 21 in. bar mill, a cold draw and wire mill, and two new heat treating and finishing buildings. New installations also include a new press shop, machine shop, a skull cracker, etc., as well as an expansion of power facilities.

JOINT MEETING

Pittsburgh-Cleveland Section

A. I. S. E.

WARREN, OHIO - JUNE 1, 1942

2 P. M. INSPECTION TRIP

COPPERWELD STEEL COMPANY, WARREN, OHIO

Trip starts from Hotel Warner.

6 P. M. DINNER

Ball Room, Hotel Warner.

8 P. M. TECHNICAL SESSION

Hotel Warner.

"Back-up Rolls" by J. A. Succop, Heppenstall Company, Pittsburgh, Pennsylvania.

"Is Design and Maintenance a Partnership?" by W. J. Fleming, Industrial Control Engineering Department, General Electric Company, Schenectady, New York.

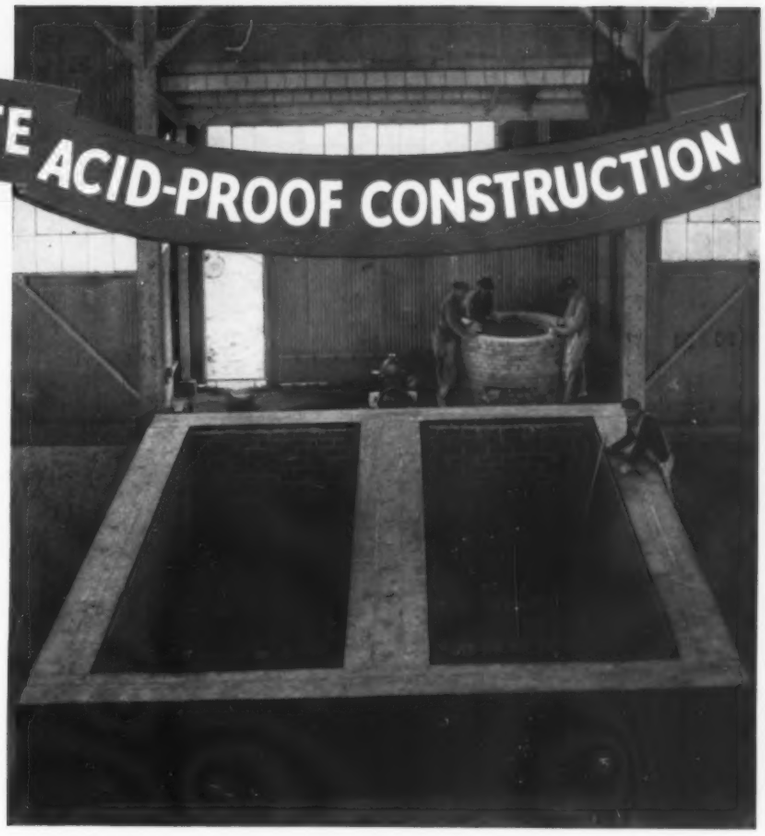
Chairman, Pittsburgh District Section
E. W. TREXLER
Superintendent, Mechanical Department
Bethlehem Steel Company, Johnstown, Pennsylvania

Chairman, Cleveland District Section
E. J. WAGAR
Assistant Chief Engineer
Otis Steel Company, Cleveland, Ohio

ASSOCIATION OF IRON AND STEEL ENGINEERS

1010 EMPIRE BUILDING, PITTSBURGH, PENNSYLVANIA

UP-TO-THE-MINUTE ACID-PROOF CONSTRUCTION



AFFORDING SUPREME

ACID-RESISTING QUALITIES, IMPERVIOUSNESS TO HIGH TEMPERATURES ...ABRASION AND TURBULENT LIQUIDS

THE lining, next to the corrosive bath, is a combination of Atlas acid-proof brick and KOREZ, a chemically setting resin cement. Into the back course of the brick is poured molten Tegul-VITROBOND, an improved sulphur cement. The heat given off during solidification of the Tegul-VITROBOND converts the KOREZ resin cement to its final set in a short time. Tank is then ready for immediate service.

This type construction withstands temperature changes and does not deteriorate under high temperatures nor contaminate the acid bath. Atlas Dual Construction is:

- Inert to hot acid and hot lime solutions
- Able to withstand operating temperatures to 250° Fahr.
- Unaffected by local overheating, whether from faulty steam jets, or from heat generated by the addition of concentrated acid.
- Resistant to Oils . . And its construction requires less labor.

Modern acid tanks of ATLAS DUAL CONSTRUCTION, in the Copperweld Steel plant at Warren, Ohio

Atlas has pioneered notable improvements in pickling tank design and construction materials. These improvements include Atlas Dual Construction, Rubber Expansion Joints in acid-proof brick sheathings, Tegul-VITROBOND plasticized sulphur base acid-proof cement, Carbon Brick — Carbo-VITROBOND tank linings for nitric and hydrofluoric acid mixtures, used in pickling stainless steel, acid-proof brick with scored surfaces, insuring maximum bond, triple acid-proof membranes.

Atlas Construction is used in more than thirty continuous pickling lines for pickling wide strip steel, each line over 300′ long, also in numerous batch pickling tanks, neutralization and acid-disposal equipment, acid-proof sewers, floors, etc. Atlas Dual Acid- Alkali- Water- and Oil-proof linings serve in large steel mills, chemical and metal refinery plants. Technical booklets on modern acid-proof construction will be sent on requst.

Tegul- VITROBOND

THE ATLAS MINERAL PRODUCTS CO. OF PA. — The House Jointing Materials

The ATLAS MINERAL PRODUCTS COMPANY

OF PENNSYLVANIA — MERTZTOWN, PA.

*ATLANTA, Georgia — 175 Spring St., S. W.
*CHICAGO, Illinois — 333 N. Michigan Ave.
*DALLAS, Texas — 3921 Purdue Street
*DETROIT, Michigan — 2970 W. Grand Blvd.
*KANSAS CITY, Kansas — 1913 Tauromee Ave.
NEW YORK CITY — 280 Madison Ave.
PITTSBURGH, (10) Pa. — Old Boston Road
TORONTO, Ontario — McRae Engineering Equipment Ltd., 11 King Street, West

The ATLAS MINERAL PRODUCTS Company of CALIFORNIA—Redwood City, California

*DENVER, Colorado — 1921 Blake Street
*HONOLULU, Hawaii, U.S.A. — Lewers & Cooke, Ltd.
*LOS ANGELES, Calif. — 817 Yale Street
*SEATTLE, Washington — 1120 Eighth Avenue, South

* Stocks carried at these points

With nothing short of modern entering into this new steel plant, the ladle handling job quite naturally went to ALLIANCE . . . a 50-ton ladle crane with a 15-ton auxiliary hoist, span of 75′0″.

In addition to Ladle Cranes, ALLIANCE designs and builds Ingot Strippers, Soaking Pit Cranes, Standard Cranes, Gantry Cranes, Ore and Coal Bridges, Open Hearth Charging Machines, Slab and Billet Charging and Drawing Machines, Car Dumpers, Forging Manipulators, Coal Pier Equipment, Rolling Mill Machinery and Special Machinery to your individual requirements.

THE ALLIANCE MACHINE COMPANY
ALLIANCE OHIO

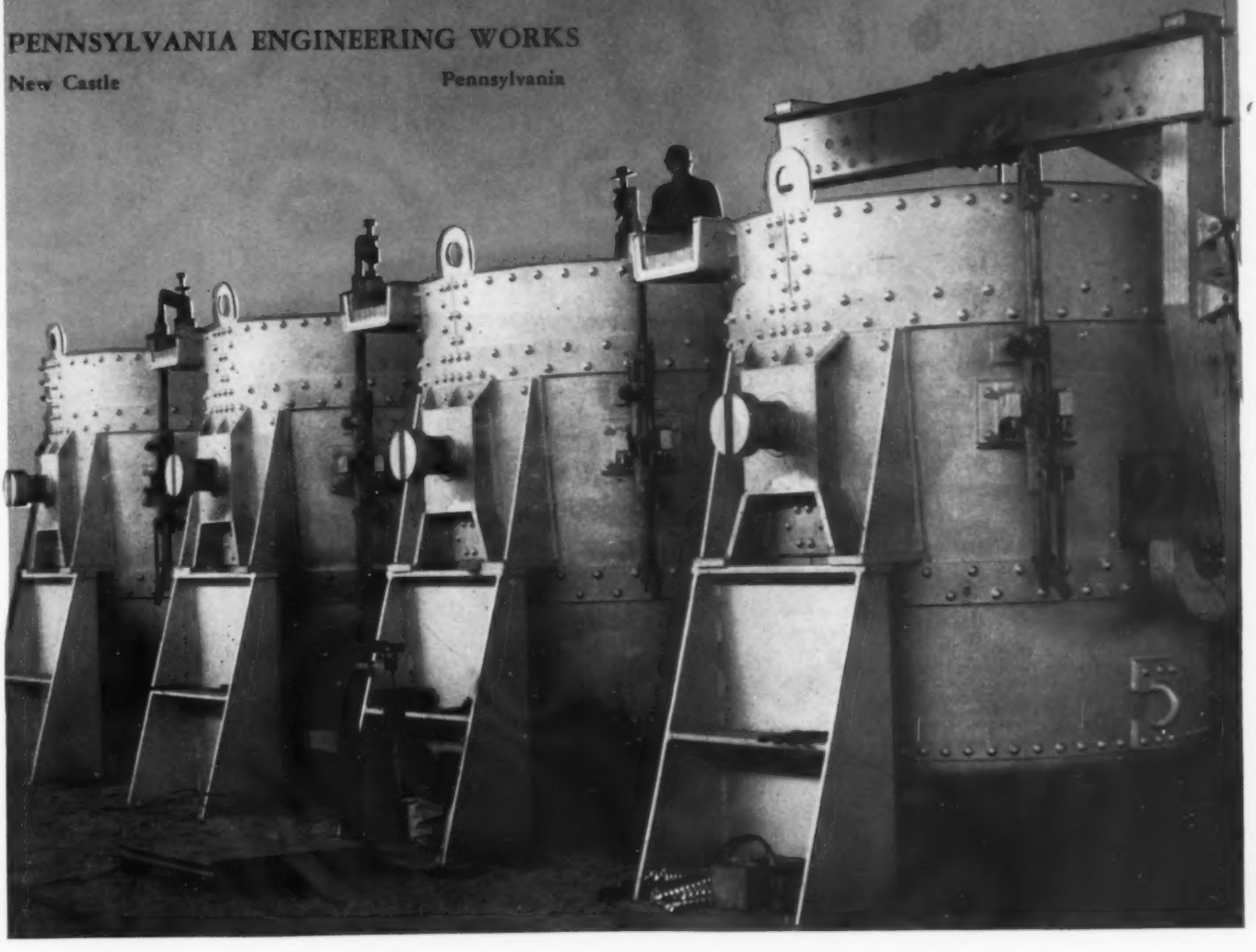
LADLES

for Copperweld Steel Co.

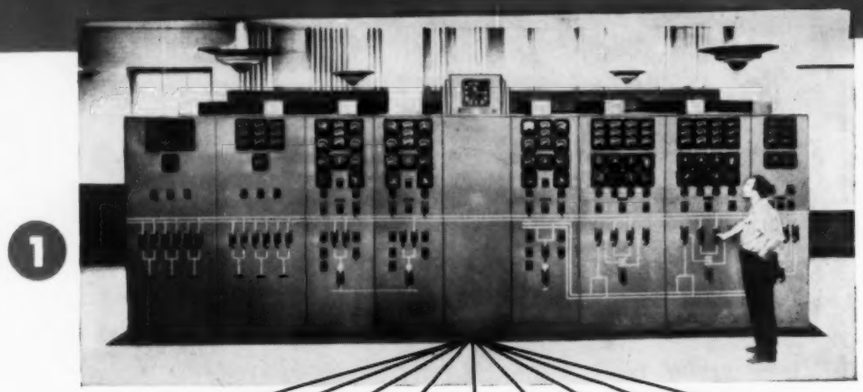
This row of sturdy, riveted, bottom pouring ladles — furnished for Copperweld Steel Company's new plant at Warren, Ohio, is but small evidence of PENNSYLVANIA ENGINEERING'S contribution to the steel industry . . . Designers and builders of Blast Furnaces, Duplex Steel Plants, Hot Metal Mixers, Converters, Ladles, Open Hearth Furnaces — stationary and tilting, Cupolas, Hot Metal Cars, Charging Cars and Rolling Mill Tables, which qualifies this organization to solicit your individual requirements in the industry.

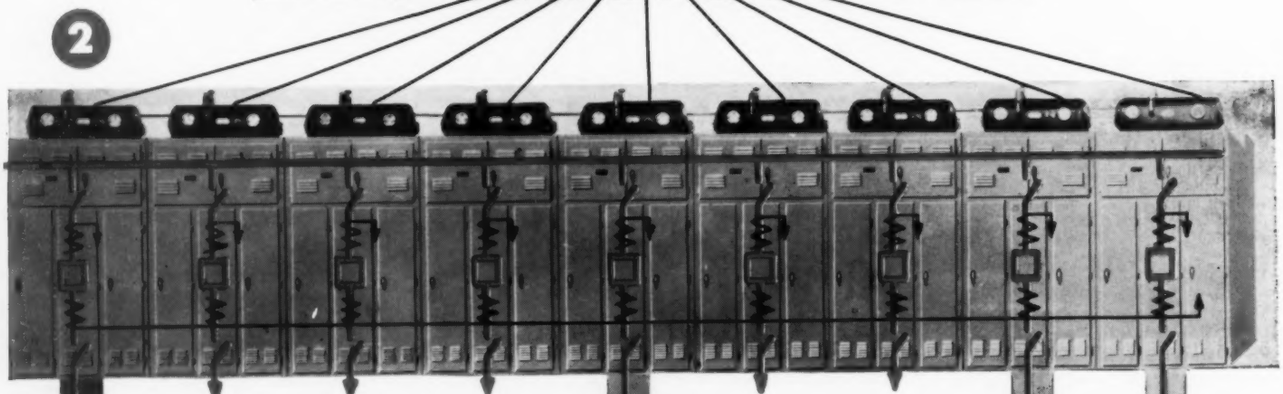
PENNSYLVANIA ENGINEERING WORKS

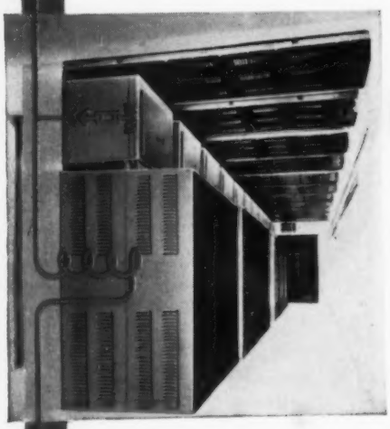
New Castle Pennsylvania

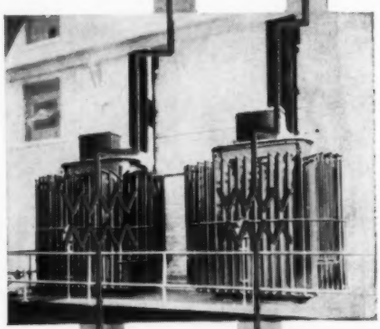


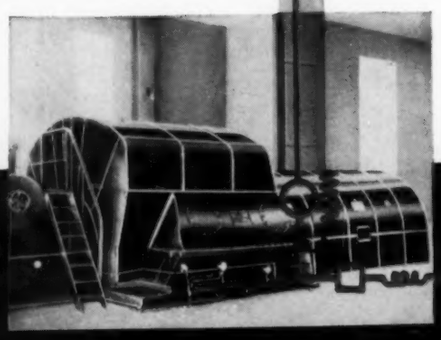
Co-ordinated METAL-ENCLOSED SW











SWITCHGEAR FOR YOUR ENTIRE STATION

ALL BUILT TO WORK TOGETHER

1. **Metal-enclosed Duplex Switchboards** for centralized control and metering.
2. **Metal-enclosed FH Cubicles** for main power circuits, complete with air-blast or low-oil-content circuit breakers and all necessary primary equipment.
3. **Metal-enclosed Reactor Equipments** for the feeder circuits.
4. **Metal-enclosed Cable Entrance Equipments** for the feeder circuits.
5. **Metal-enclosed Bus Runs** for all primary connections.
6. **Metal-clad Switchgear** for the medium-capacity auxiliary circuits, complete with air or oil circuit breakers.
7. **Metal-enclosed Drawout Air Breaker Equipments** for the low-voltage auxiliary circuits, complete with circuit breakers, buses, interconnections, and interlocks.

SELECT ALL YOU NEED . . . at one time
INSTALL IT ALL . . . as a unit

- ★ A single transaction—one company responsible
- ★ Speedy, easy installation at low, predictable cost
- ★ It's all designed as a single unit—complete co-ordination of all functions
- ★ Increased safety and operating dependability

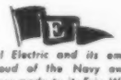
THESE are our *standard* switchgear equipments—but they're tailored for today's tremendous wartime requirements.

You can select them easily, get them soon, put them on the job weeks sooner than is possible with non-standard equipment. They're fully co-ordinated and metal-enclosed, giving greater-than-ever dependability to stations supplying power for today's *must* production.

Simplifies Over-all Station Design

When you select *any one* of these metal-enclosed equipments you get it ready to set in place and connect. You save installation time, and space as well.

When you select *a number*—or all—of these equipments, you get more of these savings in time and space, *plus* an extra degree of over-all co-ordination that may make possible a simplification of your entire station design. What's more, all you need do is send us a simple one-line diagram showing the equipment you need. We'll go right to work on *standard* equipments. Ask your G-E office for our new bulletin, GEA-3742. Or write to *General Electric Co., Schenectady, N. Y.*



General Electric and its employees are proud of the Navy award of Excellence made to its Erie Works for the manufacture of naval ordnance.

GENERAL ELECTRIC

FUEL OIL
NATURAL GAS

TIME IS SHORT!

Change to the Victory Fuel

PULVERIZED COAL

TONNAGE INCREASE .. 15%
FUEL SAVINGS 38%
AMORTIZED IN .. 2 YEARS
OPERATION *(Automatic Control)*

FROM THIS — TO THIS

After changing from an obsolete system to the new AMCO Pulverized Coal System, this installation operated for over a year without the expenditure of a dime for maintenance. This means, in dollars and cents, that the new AMCO Furnace with pulverized coal equipment, was amortized within 2 years.

If you wish further information as to the possibilities in your plant, write us at once!

YOU CAN ADAPT PULVERIZED COAL TO YOUR PLANT . . . . why wait .. MAIL COUPON TODAY

The Amsler-Morton Co., Fulton Bldg., Pittsburgh, Pa.

Please send us further information and booklet entitled "PULVERIZED COAL, the Victory Fuel."

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The AMSLER-MORTON *Company*

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3

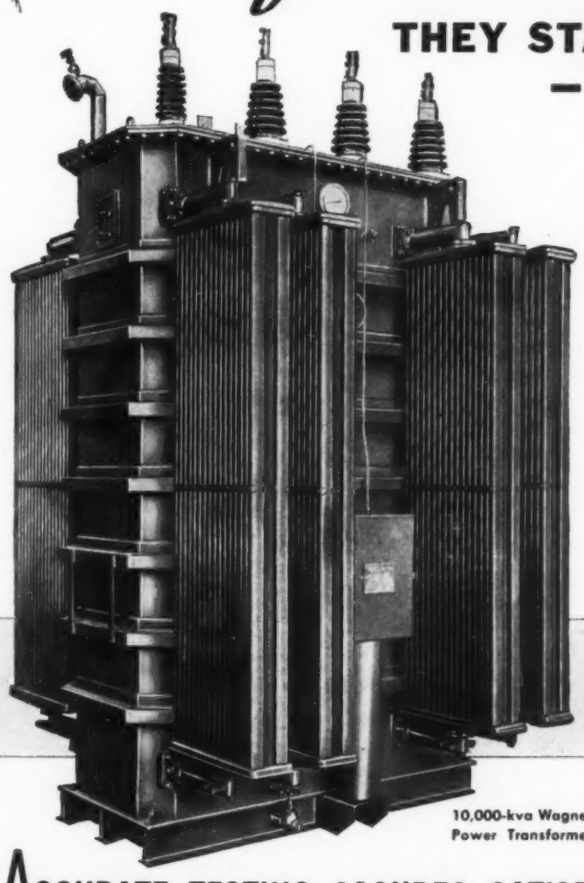
NO TIME OFF
NO SHUTDOWNS
...for WAGNER *Transformers*

THEY STAY ON THE JOB DAY AND NIGHT —SEVEN DAYS A WEEK! ›››

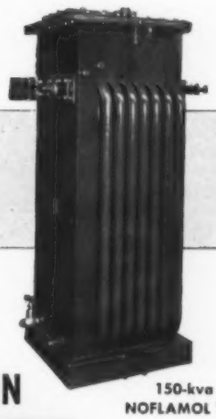
A dependable, never-failing supply of electric power is an essential factor in the present high-speed production of war materials throughout the steel industry. Steel plants have been asked to "carry the load"; time off and shutdowns due to faulty transformers cannot be tolerated.

The thorough dependability of Wagner Transformers, established by almost 50 years of outstanding service in industry, has given them an enviable reputation.

You can effect considerable savings in operating and maintenance costs by specifying Wagner for all of your transformer requirements.



10,000-kva Wagner Power Transformer

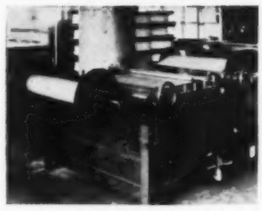


150-kva Wagner NOFLAMOL Transformer

1½-kva Wagner Air-Cooled Transformer

75-kva Wagner HEX Transformer

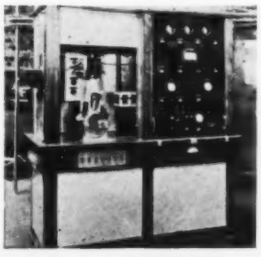
ACCURATE TESTING ASSURES SATISFACTION



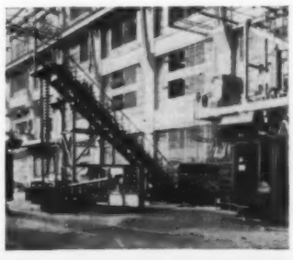
Above, Insulation-Testing Machine. Used to make sure that insulating materials have characteristics that meet Wagner's rigid specifications.

Right, "Epstein test" of Silicon Steel. Every heat in each shipment of core lamination is rigidly tested by Wagner for specified electrical and physical properties.

Below, Surge Generator. Used primarily for impulse-testing of transformers and special testing of various types of insulations.



Left, Cathode-Ray Oscillograph. Used with surge generator to obtain records of the surges which are applied when impulse-testing transformers.



For complete descriptive literature on the design and construction of Wagner Transformers write for bulletins TU-180 (Distribution) and TU-181 (Power). They will be sent FREE upon request.

Wagner Electric Corporation
6400 Plymouth Avenue, Saint Louis, Mo., U.S.A.

T42-4
I&SE

Gentlemen:

Please send me bulletins TU-180 and TU-181.

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Send for COMPLETE LITERATURE

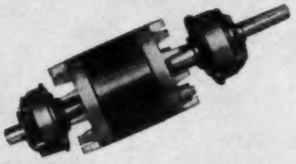
MOTORS *can't wear* GOGGLES -so WAGNER BUILDS PROTECTION FROM DUST, DIRT, FLYING PARTICLES, FUMES and ABRASIVE MATERIALS *into* CP MOTORS

Steel plant operators know that goggles prevent eye injuries and save man-hours. Belts and gears are housed for protection of workers, but in many cases motors of open frame construction are still being used in surroundings where dust, dirt, abrasive materials, steel chips, filings, and acid fumes are prevalent. As a result, motor windings become clogged, bearing surfaces wear excessively – motor life is shortened, causing valuable machine-hours to be lost.

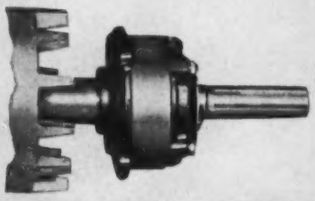
Regardless of the kind of auxiliary equipment they are driving, Wagner CP motors stay on the job, requiring no maintenance other than periodic inspection and oiling, despite the destructive elements in the surrounding atmosphere. Keep your production at top peak – eliminate shutdowns with Wagner CP motors.

FEATURES OF WAGNER *CP* MOTORS

WINDINGS—The windings are insulated with the best materials obtainable, used in generous amounts. The windings are pre-formed to exactly fit the stator slots without crowding. They are effectively insulated from the stator punchings by cuffed slot-cells made of tough fibrous material. The exposed parts of the windings are completely taped well into the slots, and the assembled stator windings are treated with high-grade insulating varnish, giving the coils a glossy surface for easy cleaning.

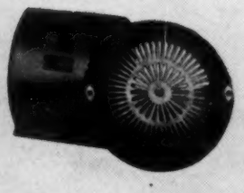


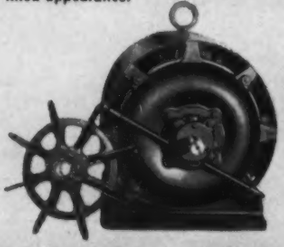
ROTOR—The squirrel-cage is of aluminum, cast under heavy pressure to completely fill the closed rotor slots and the moulds which form the end-rings. The rotor bars and end-rings make complete and intimate contact with the core iron, facilitating heat transfer and absolutely eliminating squirrel-cage vibration.



BEARINGS—Full cartridge construction for the ball bearings makes it impossible for dust or dirt to reach them even when the rotor is removed from the motor. The cartridges are heat treated, and then machined to dimensions which are held to tolerances less than a thousandth of an inch, to match the accurate dimensions of the bearings. Wagner CP motors are quickly lubricated without interrupting their operation.

STATOR AND FAN SHIELDS—The stator shield is formed from steel plate and is rigidly bolted to the motor frame. The fan shield is also formed from steel plate with the grating as an integral part of the shield. No wire mesh is used because of its lack of rigidity and consequent inability to protect the ventilating fan. Because of close tolerances and snug fit between stator and fan shields, the motor presents a streamlined appearance.

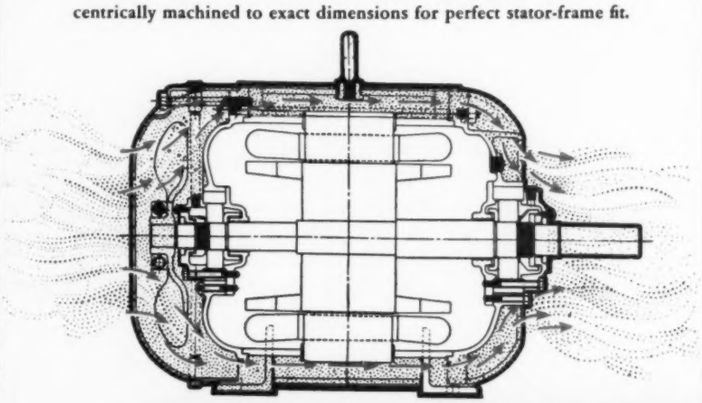




VENTILATION—The air ducts of Wagner CP motors are extra large and do not become clogged by dust or dirt. The ventilating fan is of aluminum, does not produce sparks when accidentally hit by metal, and moves a large volume of air at high velocity.

TOTALLY-ENCLOSED FAN-COOLED

Wagner type CP totally-enclosed fan-cooled motors have two frames: an outer frame which guides a strong cooling draft over the motor, and an inner frame which protects the vital parts of the motor against the entrance of destructive agents. Ball bearings are used throughout. Cartridge completely seals bearings against dust and dirt when the rotor is assembled in or removed from the motor. Endplates are concentrically machined to exact dimensions for perfect stator-frame fit.



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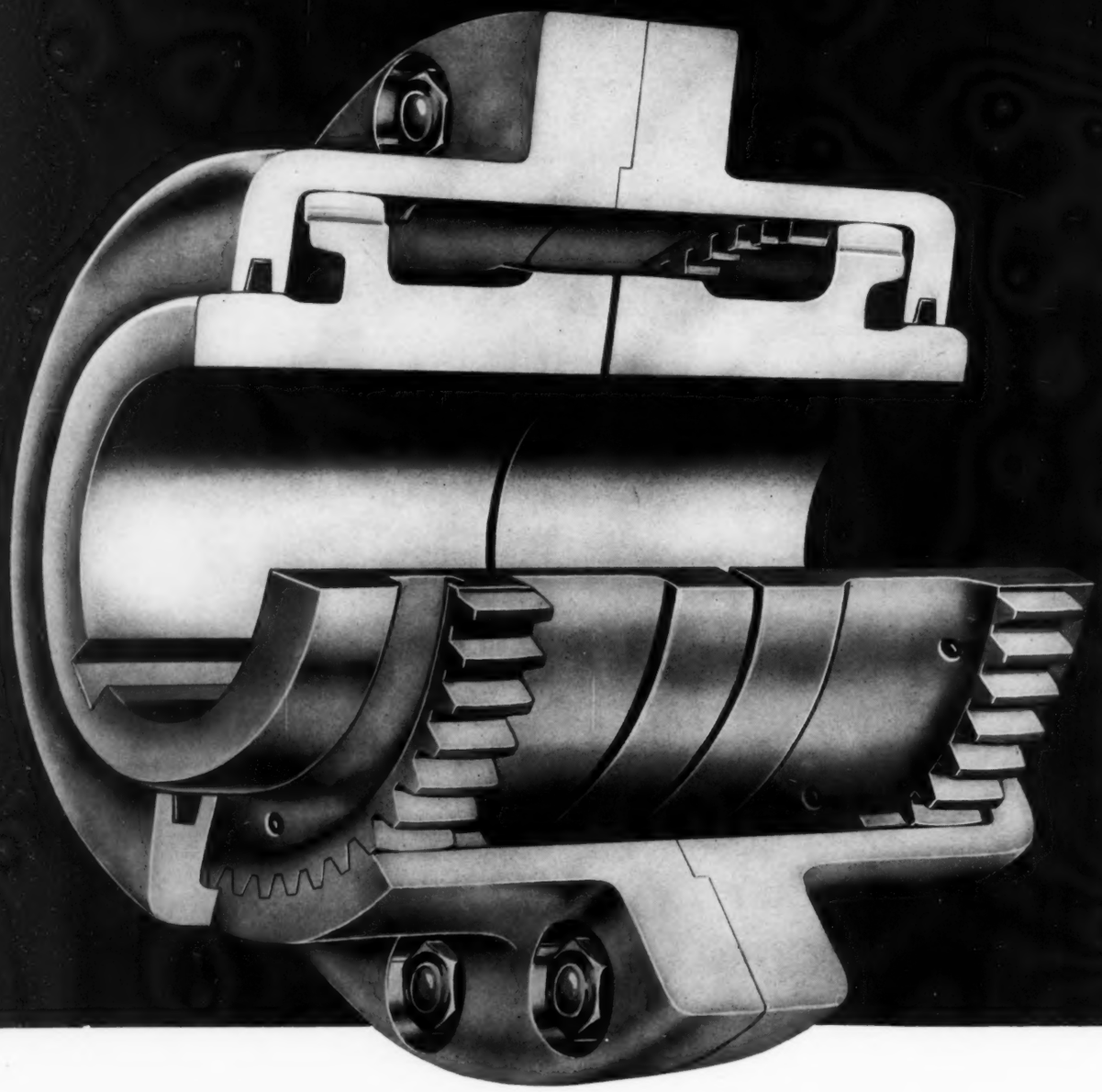


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

Report of Field Tests on

I R DROP COMPENSATION

By G. E. Stoltz

Manager, Metal Working Engineering, Industry Engineering Department

WESTINGHOUSE ELECTRIC & MFG. CO.

East Pittsburgh, Pa.

PRESENTED BEFORE THE A. I. S. E. ANNUAL CONVENTION, CLEVELAND, OHIO

▲ THE ultimate performance of a cold strip mill is to roll its product at high speeds, accurate gauge, with good surface, and without breaks. While this has not been an easy assignment in the past, it is becoming more difficult, due to the trend toward thinner gauges, harder and more brittle grades of steel, at still higher rolling speeds.

While considerable progress has been made during the last few years, there are many problems remaining to be solved, and I think it can be assumed that we are in the midst of this development rather than near its end.

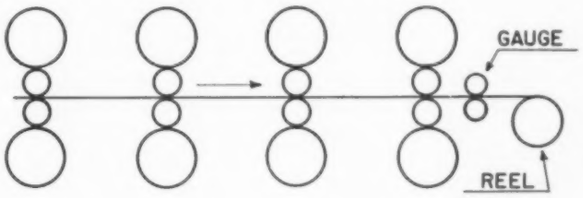
Operators have considerable freedom if strip is rolled on a single stand four-high mill with front and back tension reels. The performance of the mill and the character of the product rolled will depend on the speed at which the mill is operated, the roll pressure used, the front and back tension, the crown of the rolls, the lubrication of the metal as it passes through the rolls, the value of the drafts taken and the facility with which the coolant removes the heat from the strip and rolls. The operators must be trained to adjust and control all of these factors to produce the tonnage and quality of product that normally should be expected.

They however are free to modify the individual drafts from time to time as they may choose, they can increase or decrease the speed of operation on any pass without restriction as to what they may care to do on succeeding passes. In fact they can treat each pass as an independent operation.

When rolling strip on a tandem mill the work in each stand must be carefully coordinated with that which is being done in the other stands. Any adjustment made in any one of the stands, whether it be roll setting, speed, lubrication of the roll surface and strip, or tension between stands, will automatically modify the work being done in the other stands. The final result obtained is a summation of the work done in each stand, which is so inter-related that only highly skilled operators are able to keep all of these factors in each stand in proper

Figure 1 — Conditions prevailing on typical 4-stand tandem tin plate mill, illustrating some of the problems involved.

FOUR STAND TANDEM COLD MILL



(ROLLING .076"X 28" TO .01"X 28"X 10,000')

1 - DELIVERY SPEED FEET PER SECOND.	40'
2 - THICKNESS OF FINISHED PRODUCT.	.01"
3 - TOLERANCE OF FINISHED THICKNESS.	.0005"
4 - CROSS SECTION METAL BETWEEN LAST TWO STANDS.	.335□"
5 - TENSION BETWEEN NOS. 3 AND 4.	10,000#
6 - TENSION PER SQ. IN. METAL BETWEEN LAST TWO STANDS.	30,000#
7 - TOTAL H.P. USED TO DRIVE MILL.	7,000
8 - TIME TO ACCELERATE.	8 SEC.
9 - EQUIVALENT H.P. REQUIRED TO ACCELERATE.	2,000
10 - TOTAL H. P. DURING ACCELERATION.	9,000

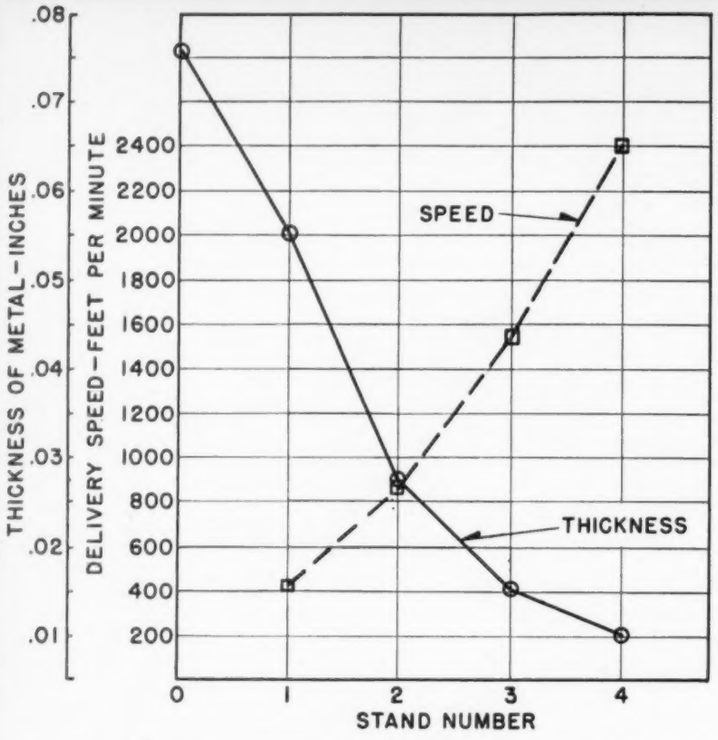


Figure 2 — Typical drafts and delivery speeds of a 4-stand tandem tin plate mill.

Figure 3 — Curves showing current, tension between stands, bus voltage and speed of a 4-stand tandem sheet mill equipped with flat speed regulated motors.

adjustment. An overall program must be selected such that where one stand completes its operation the succeeding stand can start. As a matter of fact with tension between stands they must work in unison. Tension automatically compensates for any drift of the other factors from their predetermined settings.

It is not surprising that a touch here or a timely adjustment at some other point is required by skilled operators to keep the strip flowing through the mill at such dazzling speed with machine tool accuracy of finished gauge. It is also just as true that a defect in the strip or some improper adjustment can wreck the operation in an instant and without warning.

Figure 1 is a diagrammatic sketch of a typical 4-stand tandem cold mill used in rolling light gauge strip for tinplate with a tabulation of some of the more important operating conditions that prevail on this type of mill. It is not uncommon to finish strip less than .01 in. thick, within tolerances of plus or minus .0003 in., delivered at 40 fps with tension amounting to 30,000 psi and roll pressures of 1,500,000 lb.

The performance of such a mill is based on the condition, that the same volume of metal must be delivered from each individual stand in any given time. If this is not done the strip will tend to tear in two or accumulate a loop. The adjustments of the individual motor speeds

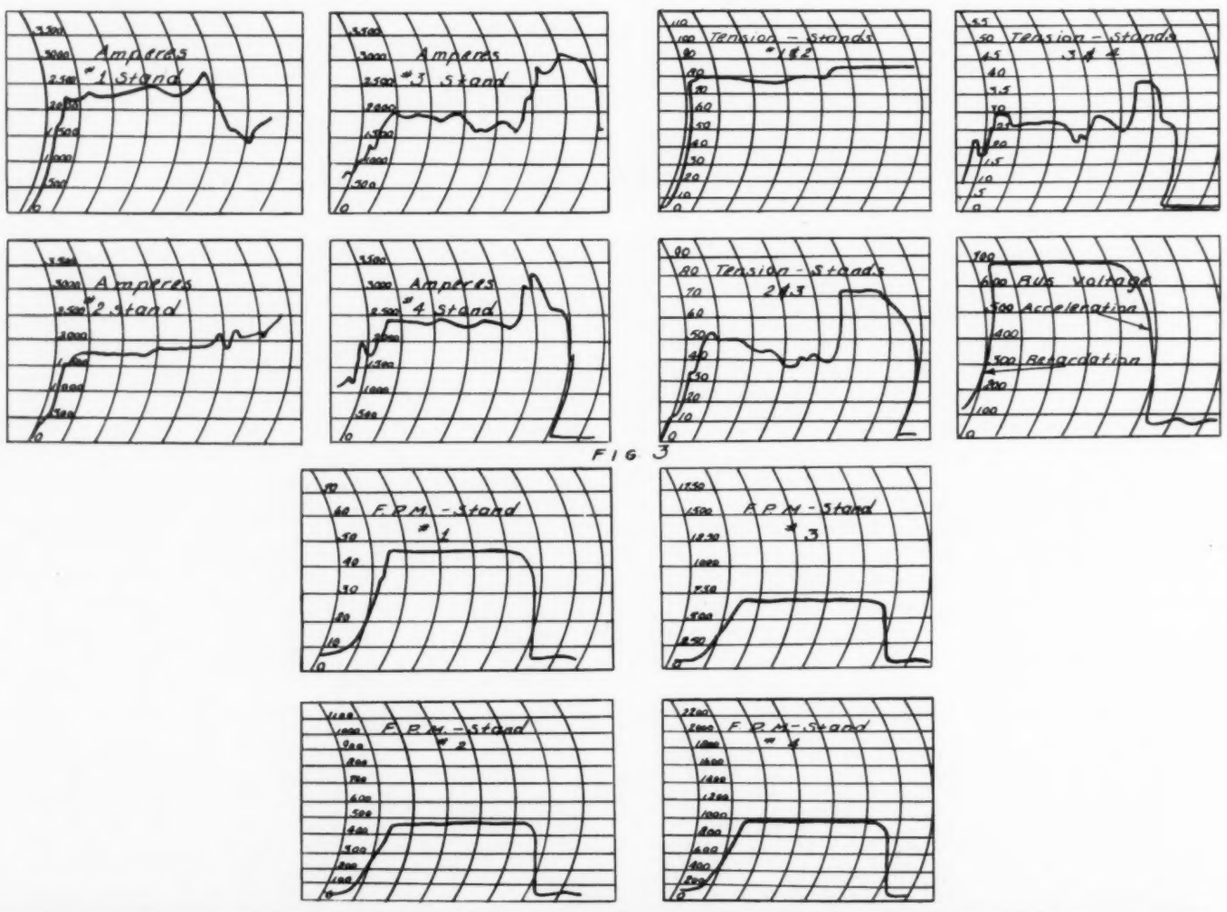


FIG 3

therefore depend upon the thickness of the strip being delivered from the stand each motor drives.

If .076 in. strip is drafted in accordance with the schedule shown by the full line curve of Figure 2, the delivery speeds of the strip will be as shown by the dashed line. If we multiply the thickness of the metal leaving each stand by its delivery speed, the same product must be obtained for all of the stands. A tabulation of these values with their common product is shown in Table I. This explains why, with a given gauge of strip entering the mill and a fixed setting of the rolls, it is necessary to maintain a definite speed relationship between the motors in order to obtain the proper gauge from the final stand. If machine tool accuracy is to be obtained in the final thickness of the strip, these motor speed adjustments must naturally be closely held.

The performance of a mill with flat speed regulated motors is well illustrated by the graphic curves showing tension, armature current, bus voltage, and delivery speeds in Figure 3. It will be noted that the bus voltage and motor speeds are as close to constant values as can be recorded with instruments of this type while the tension between stands varies over wide ranges. It is this maintenance of speed adjustments and variation of tensions that causes the mill to tend to automatically hold gauge.

Some of the early tandem mills were installed using constant current regulators to control the driving motors, as it was felt best operation would be obtained under this condition. Later it was recognized that under certain circumstances the constant current regulators did just the opposite of what they should have done. If the physical properties of the strip changed, the gauge tended to change. Without current regulators and with flat speed regulation, the motors would continue to operate at their previous fixed speeds and the change in tension would tend to hold constant gauge. With constant current control, the regulators would cause the motors to take constant current regardless of any changed rolling condition. To accomplish this the motor speeds would be adjusted to increase tension when it should be decreased, and decrease it when it should be increased. When this was realized current regulators were omitted from the main driving controls and our effort directed to the design of motors with flat speed regulation.

The importance of this step can be appreciated if we examine what happens if we assume a soft spot enters the rolls of the last stand driven by a flat speed regulated motor. The soft spot will allow the rolls to come closer together and deliver thinner strip. When this occurs the last stand will be delivering less metal than its preceding stand which will reduce the tension between these two stands to a point where the gauge out of the last stand will be restored to its normal value. If a hard spot enters the rolls, they will be spread allowing an increase in the amount of metal to be delivered. When this occurs increased tension will develop to automatically reduce the metal to its normal gauge.

The problem of rolling cold strip on a tandem mill would be greatly simplified if flat speed regulated motors were used and the mill could be kept in continuous operation at a constant speed. The operation, however, is greatly complicated by the necessity of slowing the mill down to threading speed to enter each new coil. Two disturbing conditions arise when this is done, one being electrical and the other a rolling condition.

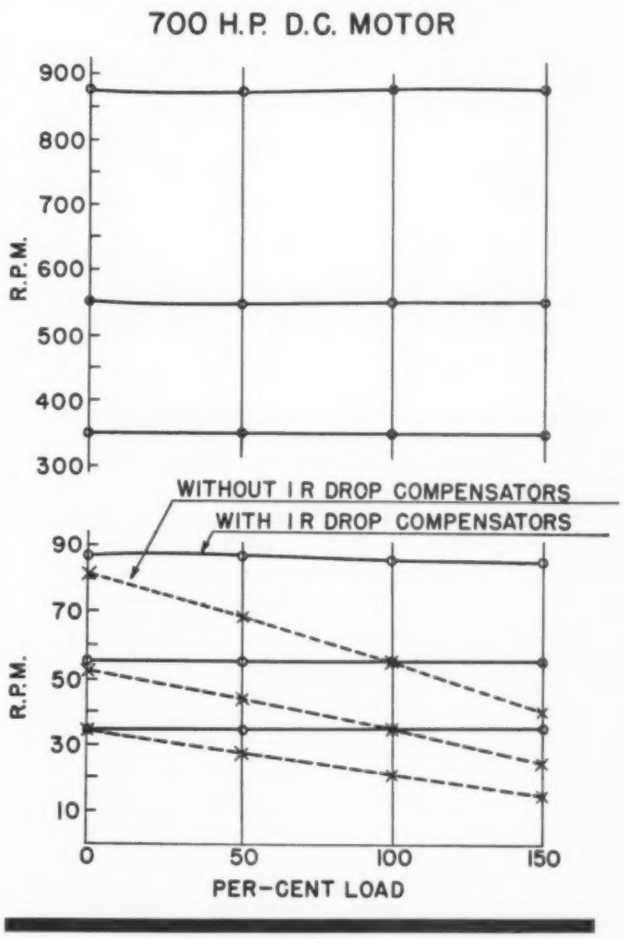
The electrical disturbance is due to the tendency of the motors to depart from their predetermined speed relation as the mill is retarded to its threading speed. This is particularly true on the newer high speed mills

TABLE I

Four Stand Tandem Cold Mill

Stand number	Thickness of metal leaving stand, inches	Delivery speed, fpm	Product of thickness and delivery speed
0	.076	....	....
1	.0559	429	24.0
2	.0279	860	24.0
3	.0156	1538	24.0
4	.0100	2400	24.0

Figure 4 — Speed regulation of d-c adjustable speed motor with and without IR drop compensation.



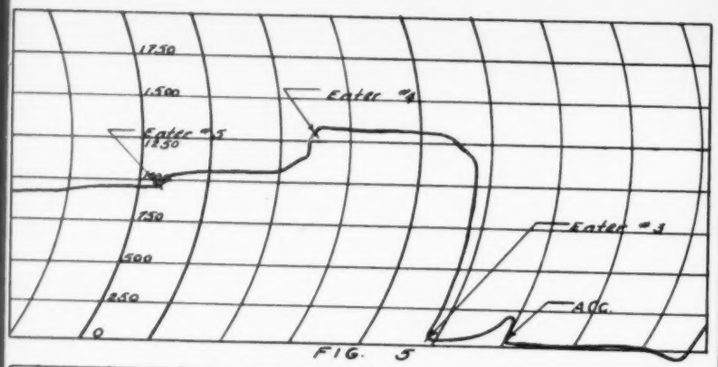
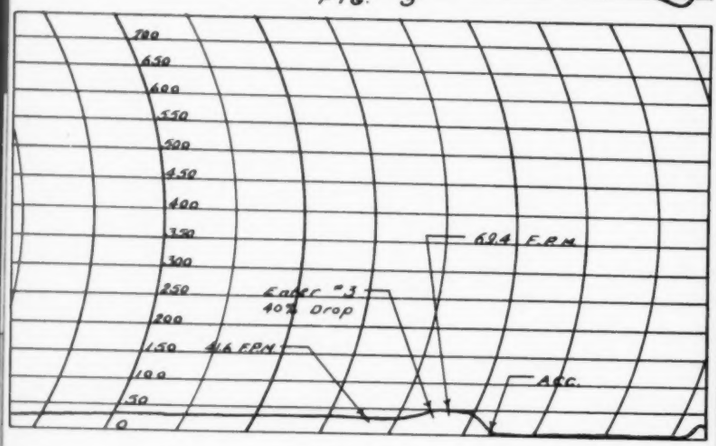


FIG. 5



Figures 5 and 6 — Graphic speed curves taken during the threading of a mill showing the operation of motors without IR drop compensation.

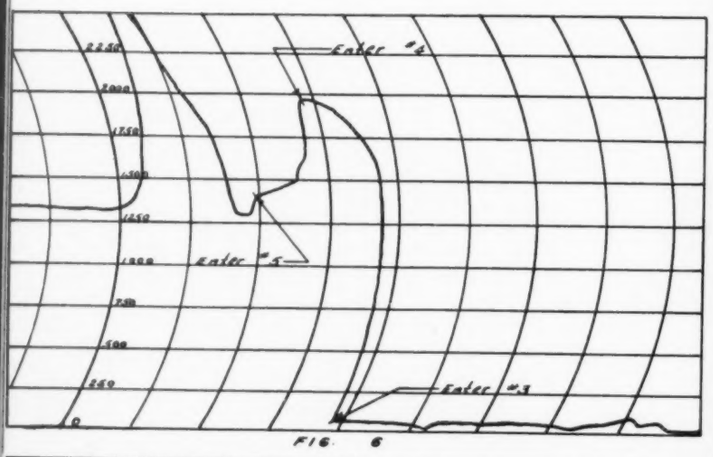
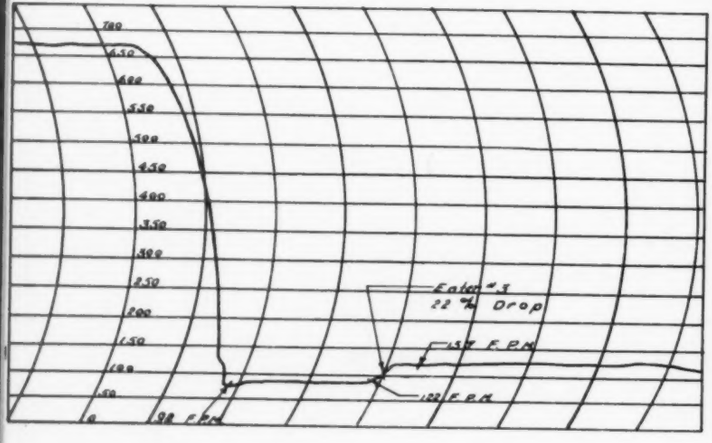


FIG. 6



where the range in speed from running speed to threading speed is extremely wide. It would only be a happenstance that the motors themselves would maintain the same speed relationship. A change in speed relationship as the motors are reduced in speed will cause a change in gauge of the metal and tension between stands.

To obtain the desired regulation throughout the speed range, the drives for recently installed high speed mills have included equipment to compensate for armature demagnetization and IR drop of the armature circuits.

The fact that speed regulation can be held to a small value at the reduced speeds with IR drop compensation is illustrated by the values shown graphically in Figure 4. These curves were plotted from tests made on a motor at full and one-tenth voltage with and without IR drop compensation.

The performance of motors at the lower speeds depend entirely upon their particular speed regulation as governed by the load they may be carrying and the strength of the field at which they are operating. These factors have no particular relationship to the requirements of the mill as it is then operating.

The performance of motors without IR drop compensation is shown by the graphic speed curves in Figures 5 and 6 taken during the threading operation of a mill. When the curve in Figure 5 was obtained, this particular stand was operating idle at 69.4 fpm. When the metal was fed into the rolls the speed dropped to 41.6 fpm which is a drop of 40 per cent. It so happened that the voltage was being raised at this particular time, otherwise under constant voltage conditions the speed regulation would have been 47 per cent. The curve in Figure 6 was taken when this stand was idling at 157 fpm under constant voltage conditions, and the speed dropped to 122 fpm when the strip was entered into the rolls. This is equivalent to 22 per cent decrease in speed. This smaller percentage drop in speed is largely due to the fact that the motor was operating at over twice the idling speed and more nearly its rated operating voltage, so that the IR drop was a smaller percentage of the armature voltage.

There are several disadvantages to threading where the motors have such steep speed regulation and such a difference between idle and load threading speeds. The first is that the speed relationship between the stand delivering the metal and the one to which it is being fed changes from schedule to schedule requiring the operator to change his technique of feeding. The operator must be a good judge of the amount of loop he puts in the strip before feeding it into the next stand as the idle stand may be operating at twice the speed it should be. Its rate of slowing down depends upon its load and the inertia of its rotating parts, and it must slow down to its load threading speed before or just as the loop is removed.

The purpose in slowing a mill down is to make it possible for the operator to thread the strip at a safe speed. Without IR drop compensation, threading must be done at the idling speed of the stands, and after this is done it is necessary to wait until the end of the coil traveling at the loaded threading speed reaches the next stand. At times this is one-half of the speed at which the operator enters the strip in the stand which causes an unnecessary loss of time. Figure 7 illustrates

the time required for strip to travel from one stand to another at low loaded threading speeds.

If we use the example illustrated in Figure 5, the time for metal to travel from one stand to another having 13 ft center distance would be 11 sec if the idling speed of 69.4 fpm were used. With the actual speed of 41.6 fpm 19 sec are required. A saving of 8 sec would be obtained if IR drop compensation were used to maintain the speed of 69.4 fpm.

This would enable the operator to accelerate the mill to full speed 8 sec sooner and if the operating speed is 2400 fpm, 320 ft of strip would be rolled in this time instead of 13 ft. Similar gains, of greater or less value would be obtained between the other stands.

Another disadvantage occurs when the operator wants a very low speed for a difficult threading operation. If a mill, having motors without IR drop compensation, is reduced to a low idling threading speed, the motors are quite likely to stall when the strip is entered into the rolls. The only recourse the operator has under this circumstance is to continually jog the mill until the difficult part of his threading operation is completed. He may raise the generator voltage to maintain speed on the loaded stands and strengthen the fields of the motors on the idle stands in order to bring them down to a safe entering speed. Any change in the field rheostat setting of course destroys the speed adjustment of the motors previously us. d before the mill was slowed down for threading, and requires the operator to reset the field rheostats after the mill is again up to speed.

The dispatch with which coils are threaded has considerable influence on the tonnage output of a mill. Schedules are rolled when little threading time is lost, but too often it is a large proportion of the time required to roll a complete coil, as is shown by Figure 8. The operator should be given every facility to ease the problem of threading.

A change in any one of the stands of a tandem mill is reflected throughout the length of the mill. This is particularly true if the motors without IR drop compensation are operating at reduced speeds, and the load conditions of the driving motors are changed. This is illustrated by Figure 9 which shows the current and speed curves of the motor driving the No. 2 stand of a 5-stand mill. At the time the strip was entered in No. 2 stand its speed happened to be near zero. The current curve clearly shows the changed load conditions of No. 2 stand motor as the metal is threaded through the mill and tension established between stands. The speed of the motor on No. 2 stand actually dropped as the metal was threaded through the mill due to the decrease in generator voltage as its load was increased. The dashed line on the speed chart has been plotted to show the speed at which the strip would have traveled if the generator voltage would have remained constant. The speeds corrected for constant voltage are as follows as the metal is threaded from one succeeding stand to another.

Metal in stands No.	*No. 2 stand speed, fpm*
1 and 2	34.6
1, 2 and 3	39.2
1, 2, 3 and 4	40.4
1, 2, 3, 4 and 5	41.4

This increase in speed from 34.6 fpm to 41.4 fpm is 20 per cent, which of course, affects gauge and tension. Not only this motor has its speed changed, but all the motors are affected with resultant changes in gauge. With such a complicated set of actions and reactions what the ultimate gauge would be is hard to predict. This disturbing factor would be minimized if the driving motors were equipped with demagnetization and IR drop compensation.

Graphic speed curves of motors equipped with IR

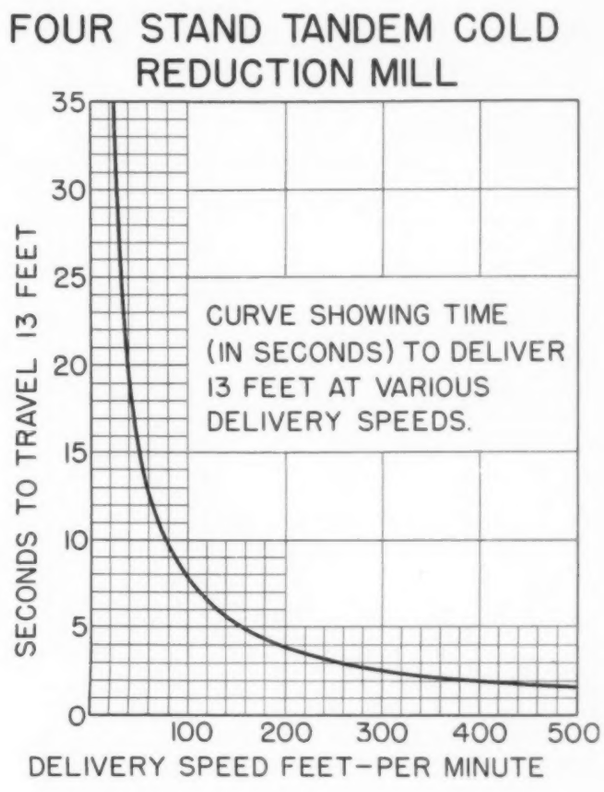
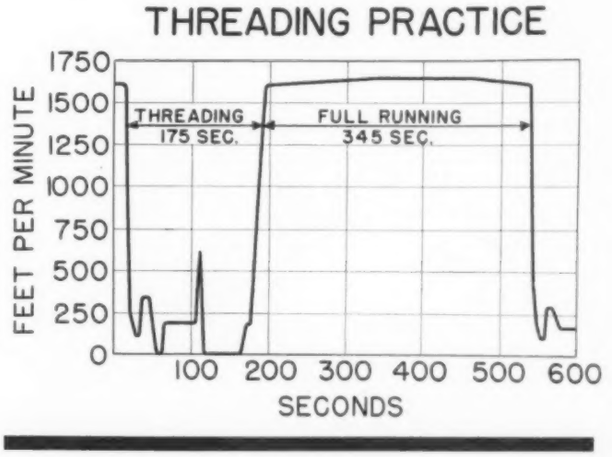


Figure 7 — Curve illustrating the time required to pass strip from one stand to another at threading speeds.

Figure 8 — Graphic chart showing the time consumed in a difficult threading operation.



drop compensating equipment are shown in Figure 10, which clearly indicate the better control of the motor speeds during the threading period.

Inspection of the voltage curve indicates frequent adjustment of the generator field rheostat with corresponding changes in motor speeds independent of their load conditions. A study of the speed charts also shows that instantaneous dropping or assumption of load has little influence on the motor speeds even at creeping values. This is true whether the generator voltage is changing or constant.

Another example of the effectiveness of IR drop compensating equipment is illustrated by readings taken at different periods of retardation when the mill is brought to threading speed. These results are shown in the following table.

	Rpm			
Volts	*1*	*2*	*3*	*4*
632	72.7	147	233	343
307	35.7	70	109	164
200	22.9	45	69	97
68	6.1	13	19	27
Per cent voltage	*Per cent speed*			
	1	*2*	*3*	*4*
100	100	100	100	100
48.5	49.1	47.6	46.7	47.8
31.6	31.5	30.6	29.6	28.3
10.75	8.3	8.8	8.2	7.9

On this particular coil the bus voltage at full speed was 632 volts, and the speed of the four-stands were respectively 72.7, 147, 233 and 343 rpm. Speed readings on all four stands were obtained at reduced voltages of 307, 200 and 68 volts.

By assuming the operating speeds of the four stands, each to be 100 per cent, comparative speed relationship can be obtained for each of the reduced speeds. With a bus voltage of 307 volts the speed of the four stands were as close to 48 per cent as accuracy in reading would permit. At 200 volts the speeds average 30 per cent and at 68 volts slightly over 8 per cent.

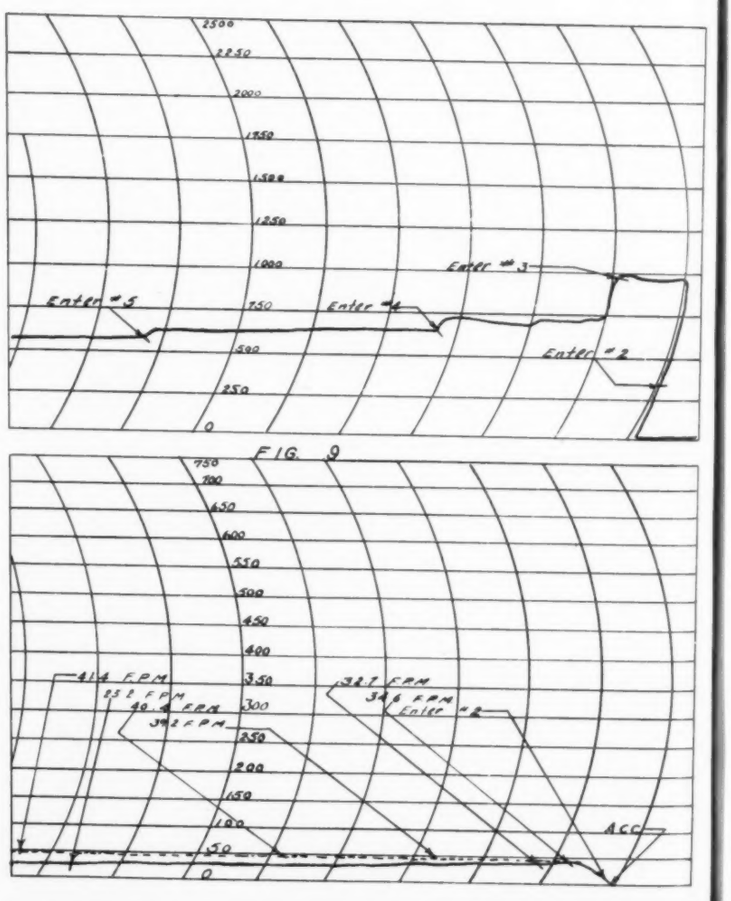
The effectiveness of IR drop compensation usually demonstrates itself to new operators the first time they push the emergency stop button with metal in the rolls at top speed. The suddenness and ease with which the mill is brought to rest without causing any demonstration of changed rolling conditions is one of the most striking and conclusive methods of proving that IR drop compensation removes the electrical disturbing condition formerly obtained at low speeds. To bring a typical four stand mill to rest in this time requires a sudden application of braking torque equivalent to 4000 hp. With the strip already stressed to high values this enormous instantaneous introduction of new torque would quite likely tear the steel in two if accurate speed relationship were not maintained.

The per cent of full speed maintained by the individual motors during the retarding period to less than one-tenth of full speed with different loads on the various motors and each with different flywheel effect shows a remarkably close relationship. On this particular schedule the motor on No. 1 stand was operating near its full field while No. 4 motor was adjusted to near its maximum weakened field. The No. 1 motor had a low inertia effect while the No. 4 motor was near its maximum. This well illustrates that flat synchronization or any other preferred pattern of speed relationship may be obtained with demagnetization and IR drop compensation.

The other condition that changes when the mill speed is reduced to threading speed is that on most mills the gauge becomes heavy, even though the metal is still in all stands. This may possibly be accounted for by a change in the effort required to make steel flow or to some extent by a change in the thickness of the oil film in the back-up roll bearings where sleeve bearings are used. As far as we know the value of the factors that are responsible for this change have not been established.

A representative change on a mill where the thickness of the strip increases as the mill slows down is shown in Figure 11. The reductions per pass and delivery speeds shown for full speed operation are the same as those used in Figure 2. This data was taken on a mill not equipped with IR drop compensation and it was found there is considerable change in speed relationship from full speed to threading speed. The actual threading speeds were 46, 75, 136 and 180 fpm respectively for the four stands. Multiplying each of these values by

Figure 9 — Curves illustrating how a change in one stand of a tandem mill is reflected in other stands.



the thickness of strip obtained from each stand gives a constant product of 2.58. This again illustrates the basic condition that the same volume of metal must be delivered from each stand if we are to avoid accumulating loops or tearing the metal in two. In order to more clearly see the change in speed relationship, we have potted a third speed curve by multiplying each threading value by 9.33. This moves the point for the first stand up to the full delivery speed value. It will be noted that there is an increasing spread between this curve and the actual full delivery speed curve as the finishing end of the mill is approached.

On mills where rolling conditions are such that there is a tendency to increase gauge as the mill comes to a slow speed, electrical equipment with IR drop compensation adjusted to give flat speed regulation at all speeds will tend to maintain the proper gauge by increasing the tension between stands. The reason for this is that with the motors maintaining the same speed relationship they will tend to deliver the same volume of metal in a given time. The tendency to increase gauge is a greater per cent in the last stands than in the early stands, so that there will be a tendency to deliver more metal from the last stands than from the first. This simply means that the mill tries to hold gauge by increasing the tensions between stands, the tensions being increased more in the delivery end of the mill than the entry end.

Many mills avoid unnecessary loss of gauge at the tail end of the coils by only partially slowing the mill down until the strip has left the last stand. This is illustrated in Figure 10 where the metal left No. 4 stand at 440 fpm which is 29 per cent of its full speed. The tendency to roll heavy gauge is very much less in the upper range of speeds than the lower.

Threading through a new coil of course is more difficult as the mill must be operated at a slow speed for some period of time, and if there is any tendency to produce over-gauge at slow speeds there will be more time for it to develop.

I believe operators are more concerned with a reduction of the number of breaks at slow speeds than reducing the amount of off-gauge. If over-gauge is responsible

Figure 10 — Graphic charts illustrating the performance of a 4-stand tandem tinplate mill equipped with IR drop compensation during threading operation.

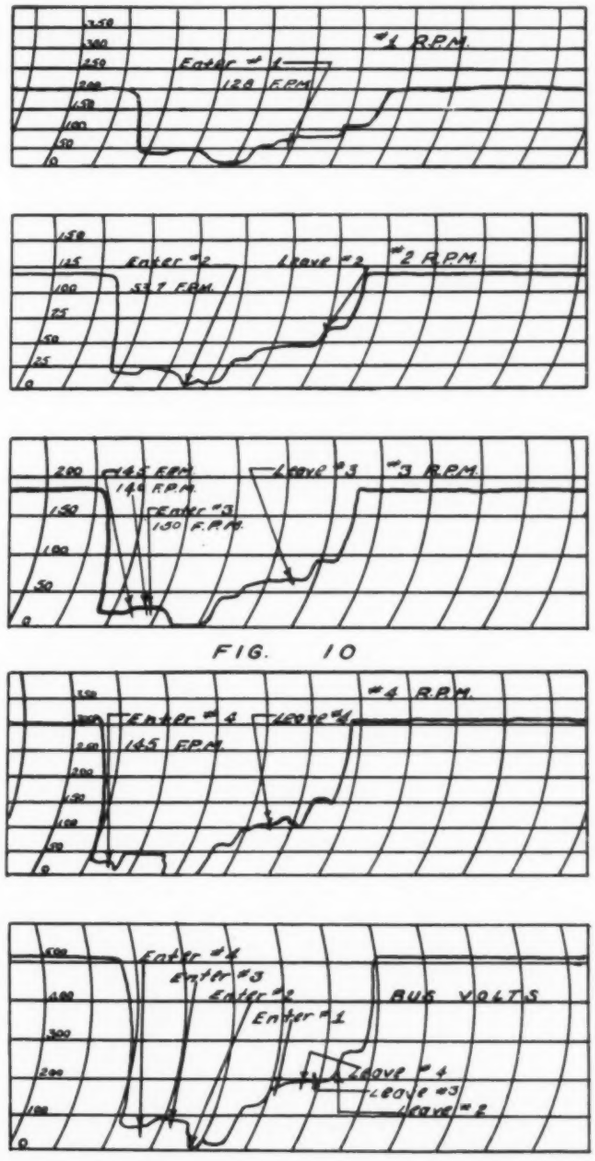
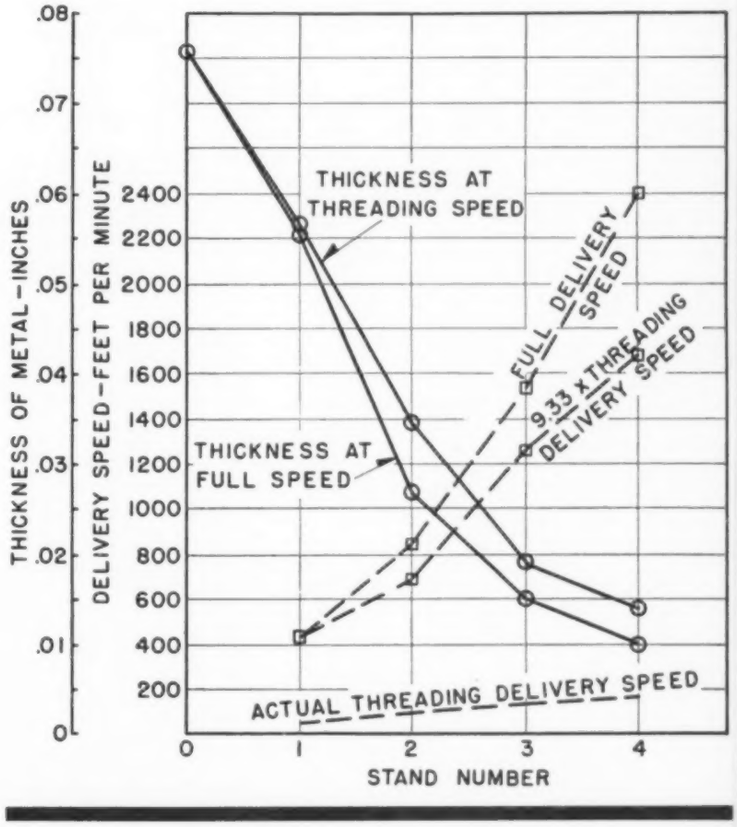


FIG. 10

Figure 11 — Relative performance of a tandem mill at full and threading speeds.



for a number of breaks then the correction of the tendency to cause over-gauge at slow speed takes on added importance. There will always be breaks due to defects in the strip or improper handling which we may never be able to avoid. However, if it were possible to offset any tendency to produce heavy gauge at slow speed and the electrical equipment were provided with demagnetization and IR drop compensation, we should then be able to maintain the same conditions of rolling at all times and more nearly approach the ultimate conditions that are obtained with the mill running at full speed.

While demagnetization and IR drop compensation solves the electrical part of the problem and added adjustment may be required if the rolling conditions are such that over-gauge cannot be entirely avoided. Again referring to Figure 11, if the metal thickness of .014 in. is the nearest approach possible to normal gauge of .010 in., then automatic speed adjustment of the motors should be made for threading speed to meet the final gauge of .014 in. The motors will operate at the same precision on this schedule as on that of rolling .010 in. at full speed. As the mill is accelerated to full speed the motors can automatically be returned to their adjustment to roll .010 in.

The error of off-gauge is less in the early stands, and the possibility of increasing tension in this part of the mill is greater due to the fact that the steel is softer than in the finishing end of the mill. Under these circumstances a further improvement can be made by holding the first motors to their full speed settings and then making adjustments in the last motors. In this manner much closer final gauge can be held than would otherwise be obtained.

Certainly we have come a long way from the old hand mill to the present day tandem mill, operating at ten times the speed and producing fifty times the tonnage. This has been accomplished by the contribution of many developments originating with the operating organizations, mill builders and electrical manufacturers.

Threading and operating at reduced speeds have been among the most difficult problems to be solved. Demagnetization and IR drop compensation has solved the electrical phase of this problem and has proven to be one of the most valuable contributions made to the art of rolling strip.

DISCUSSION

F. MOHLER, Engineer, Steel Mill Section, Industrial Engineering Department, General Electric Company, Schenectady, New York

A. M. MacCUTCHEON, Engineering Vice President, Reliance Electric and Engineering Company, Cleveland, Ohio

G. E. STOLTZ, Manager, Metal Working Engineering, Industry Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania

F. MOHLER: As most of you know, cold strip mills have been close to my heart for a good many years, and I have spent a good bit of midnight oil working on them. I agree with Mr. Stoltz that we have gone a long way in the past few years. I remember in 1929 when a mill was accelerated up to 250 fpm, the superintendent came out and said "Shut it down, boys; you are liable to kill somebody." About a month ago I saw a mill accelerate up to 3750 fpm in about six sec and I got a real thrill out of it. I think this progress has been due to the excellent cooperation of the mill builders, the steel mills, and the electrical manufacturers.

There are so many problems in the electrical control that are involved in the actual operating problems that the electrical manufacturer must have a thorough understanding of them to build a successful drive.

We have a mill with IR compensation and we have operated this same mill both with and without IR compensation. I will be frank to tell you that we are trying to find out all we can about it. To date we haven't made enough tests to make any commitments. I can say this, however, that we have accelerated this mill to 3300 fpm without IR compensation, and the only noticeable difference in operation was somewhat poorer speed regulation at threading speed. Just how it is going to affect the practical operation, I do not know. Probably after a year or so we will be able to make a more definite report.

A. M. MACCUTCHEON: It is rather difficult to enter into a discussion when there is substantial agreement with what an author has said. My discussion would be more interesting to the audience if I could select a part of Mr. Stoltz' paper and say "I do not agree with that and for the following reason," but I find myself in entire agreement with all that Mr. Stoltz has said.

Operating motors through changing speed by means of voltage control is an excellent method. It does introduce problems which are not present when the motor is operated at changing speeds through field control and with constant voltage. The problem of a high percentage voltage drop within the motor when operating at low speed is probably the main problem which is encountered when voltage control is employed. At the lower speeds, the voltage drop is a higher percentage of the applied voltage and the speed regulation consequently poorer.

In many applications there is a decided advantage in a method to compensate for this voltage drop. To accomplish such a compensation, additional expense and often additional equipment is necessary. In any par-

ticular application, the value of the result secured must be weighed against increased expense and increased complication.

Where several motors are used to operate the different parts of a group drive, it appears to me that it is helpful to separate the speed changes which are to be introduced into two classes — first, primary speed changes which may be defined as speed changes which affect the output of the product from the machine; and second, secondary speed changes which may be defined as those speed changes necessary to properly tie all parts of the machine together so that each part will operate properly with reference to each other part. If such a distinction is established, the solution to the problem encountered is often more readily recognized.

In a group drive, voltage control is an ideal method of securing primary speed changes since the voltage change is common to all the motors involved and produces a proportional change in the speed of each of the motors.

To accomplish secondary speed changes, a method must be used which can be applied to any one of the motors but not applied to all. This is obvious since the purpose of a secondary speed change is to change the speed of one motor with relation to the others in the group. Individual field control is an ideal method to accomplish secondary speed changes. If conditions permit, operation is usually better where primary and secondary speed changes are secured by two entirely distinct methods.

I have but one point further. In engineering design, we usually find that an improved result cannot be secured without some penalty. It may be cost — it may be loss of simplicity. Mr. Mohler has pointed out that mills have been operated with voltage compensation and also without. If a successful product cannot be produced without voltage compensation, it should be supplied even with the attendant penalties.

I remember one drive which was installed many years ago on a cold strip mill. Consideration was given to supplying additional equipment in order to maintain a constant speed relation between the motors when such speed relation was once established. It was decided that it would be little more expensive to later install

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the additional equipment if operation proved that it was essential. The mill was started without the additional equipment, and at the present time, 15 years later, it has not been found necessary to install it.

I think that Mr. Stoltz will agree with me that we should pay tribute to the mill operators. Many times they are able to get the desired results without the additional expense or complications. They are, indeed, very clever.

G. E. STOLTZ: I very much appreciate the remarks made by both Mr. MacCutcheon and Mr. Mohler, and knowing the student that Mr. Mohler has been on applications of this type, it is of considerable interest to find that he is working on the same phase of this subject.

I have a lot of respect for the men who roll strip on tandem mills, whether they are operating at 1500 fpm or between 2000 and 3000 fpm. There are at least six conditions that have a great deal of influence on the performance of the individual stands. They are speed, roll pressure, tension, lubrication, crown of rolls, and the manner in which the heat is dissipated. All of these must be kept under control in each of the stands and when we consider that 2000 hp may be generated in the bite of the rolls it must be recognized that considerable can happen if this amount of heat is not properly dissipated. Further it is not surprising that new conditions prevail when such a mill is slowed down in a few seconds to a threading speed where the amount of heat generated may be one-tenth of the value that was required with the mill operating at its normal speed.

What happens in a single stand under these conditions might be compared to the complicated set of conditions that are obtained when a baseball player hits a ball pitched to him. In the first place the velocity of a ball thrown to the batter may be high or it may be a slow ball, it may be a straight ball or some type of curve. The batter will vary the velocity of the bat as he swings at the ball, he may strike in a horizontal plane or in a rising or down stroke, and he may hit the ball squarely or above or below the center. There are so many factors that influence the path the ball takes after it is struck and the action occurs in such a short time that the fielders must wait until they see the ball in flight before they know the path it will take. There however would be no particular difficulty for a good mathematician to predict the flight of the ball if he knew the value of all the factors that influence its flight.

Cold strip can be rolled on one stand successfully without necessarily understanding all the conditions, but on a tandem mill I think it is important that we do understand these various factors if we are to roll with minimum breakage, particularly at threading speed and avoid overgauge with its possible cause of breaks. IR drop compensation places the performance of the motors under the operator's control rather than leave them operate at indiscriminate speeds, particularly when threading.

Smith Discussion

(*Continued from page 34*)

has been in operation for 20 months and indications are that the weld is 100 per cent successful. The section repaired was 20 in. x 35 in. and 985 lb of rod was used in making the weld.

J. S. MCKEIGHAN: The remarks about the distortion hit a tender spot in my make-up, and I want to make a remark about it, and that is this: That oftentimes people concern themselves with weld stresses and weld distortion in pieces where it doesn't make any difference.

We have run into cases, in our experience with certain types of welding, that have called for stress relief when it was really foolish. It was a waste of time and money. There is one case comes to mind now in our own district in Northern Ohio, — a customer's plant where he increased his welding from two and a half pieces a day to eight, simply by going from $\frac{3}{16}$ in. size electrodes to $\frac{3}{8}$ in., larger electrode sizes. The pieces didn't justify consideration of weld stress or stress concentration, and the small amount of distortion there was, was perfectly allowable.

The point I would like to make is this: Let's not worry everybody about the weld stresses that are left in a piece if they are a matter of, well, say, 5000 psi, or if it isn't going to affect the ultimate strength of the job we are building the piece for.

E. W. P. SMITH: Mr. White has misinterpreted the purpose of the paper. Perhaps that is due to the way it was expressed. The use of the larger electrode, an increase of just one size, would make available this army of excellently trained operators, as somebody phrased it — a figure to visualize to you what could be done now.

Mr. White does, however, bring up a question: the manufacture of equipment. Perhaps we are using the peak capacity of available equipment and will have difficulty getting additional equipment. These skilled men would be used if they were available. In other words, we would do in nine months what we do now in twelve, and we would keep on going those other three months making additional required equipment.

Mr. White mentioned speeds and undercut. That is quality. I intimated but didn't definitely say that the quality was not to be impaired. That is obvious. It is a matter of procedure which was not discussed. He brings up also the matter of selection of the electrodes. That should be included in the discussion, the selection of the proper type of electrode.

It is commonly accepted that the fewer number of passes result in less distortion from welding. Release of some of the locked-up stresses that have been rolled in at the mill may cause difficulty and inconsistent results. It has been suggested, therefore, that the step-back method be used, again a matter of procedure.

Just a word in reference to locked-up stresses. What about them? Are you worried about them? A lot of people say, "Oh, yes." Did you ever ride in a train pulled by a locomotive? What holds the tires on the wheel centers? Isn't that locked-up stress? You use them to advantage. So, we have a lot of locked-up stresses around us here and everywhere. It is not always the serious question that we sometimes think it is. I don't mean to minimize and totally disregard them, but on the other hand, they must be considered in their proper place.

Isn't it the matter of going out of shape that bothers us more? Suppose from the very beginning of welding there had been no external deformation. How much would you be concerned about locked-up stresses? I don't say you would not be concerned, but just how much?

You have an excellent example just described where the part was loaded with locked-up stresses and still served the purpose. The stress to the yield point isn't such a serious proposition providing the part is loaded under certain conditions. You are going to have a lot of trouble in finding a part that isn't, at some point or points, stressed to the yield point. On the other hand, we do find it necessary under certain conditions to give full consideration to this matter of locked-up stresses.

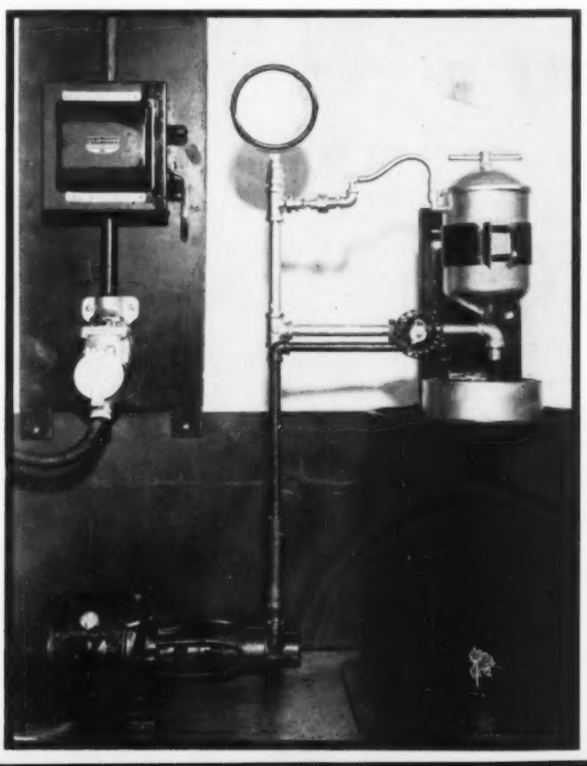
OIL FILTRATION *and* RECLAMATION

By C. A. Bailey

Assistant to Divisional Superintendent of Maintenance
Sheet and Tin Mills
CARNEGIE-ILLINOIS STEEL CORP., Gary, Indiana

▲ IT IS acknowledged that many theories of the technology of lubrication presume ideal conditions which may not exist, however, in the field. In recognition of that fact, the methods set forth in this paper are governed by economic and practical limitations. The maintenance of lubricating systems for industrial machinery is oftentimes independent of the selection of oils and only the problems involved in the maintenance of fluid lubricants will be considered. Oil circulating systems may be applied to many classes of machinery, including units involving from a few quarts to several thousand gallons. Regardless of the quantity of oil, the problems of cleanliness and chemical stability remain the same. It is generally agreed that oil does not wear out, but does change chemically and becomes contaminated with use. The greatest internal enemy of oil is oxidation, and the weakest or chemically least stable hydrocarbons will be the first to change in lubricating properties. It is this change in the oil, caused either by heat, chemical action within the lubricant or by ingress of contaminating materials, that constitutes the cause for oil filtration and reclamation.

Figure 1 — Test apparatus designed to measure the effectiveness of oil filters.



The subject of oil filtration which is essentially a form of reclamation will be discussed in connection with the maintenance of small and large oil circulating systems. The discussion of small oil circulating systems will include test data for automotive and similar equipment, while that in connection with the large systems will refer to the maintenance of large volume centralized circulating systems.

The subject of oil reclamation which utilizes filtration methods will be discussed in connection with mechanical and chemical methods of treatment. Mechanical methods of reclamation will include the description of a waste oil recovery plant using a centrifuge to recover various types of lubricating oils. A system for the classification of lubricants is outlined as an aid to identification of salvaged lubricants. Chemical methods of reclamation with the use of neutralizing clays or activated earths will be discussed as being the most complete type of reclamation and that most nearly approaching refinery procedure.

Small Oil Circulating Systems

The problems involved in small oil circulating systems are fundamentally the same as in the large systems. A small quantity of lubricant is involved and the machinery served is less massive. Each molecule of oil has to do more work, with less attention, which adds to the complication of the problem. Applications such as roll grinder ways and thread grinders present a lubrication system involving a few gallons of oil circulated by a pump. If the quantity of lubricant is small, its physical condition is often given less consideration.

Lubrication of internal combustion engines has resulted in the development of filters of the small capacity type adaptable to circulating systems of various sizes, While the unit designed for installation in a passenger car may not be suitable for the roll grinder system, the filter manufacturers have engineered their clarifying equipment to be comparatively flexible for industrial applications. Therefore, the foregoing statements which appear to be applicable only to automotive equipment, are indicative of results that can be expected in many industrial machine units.

It is quite evident that the service expected of lubricants for internal combustion engines is one of the severest that will be found; and, in order to understand the function of an oil filter, it is desirable to consider

TABLE I

Oil-Filter Test Data for Color

Filter	Oil pressure, psi		Capacity, gal per hr	Remarks
	Start	Finish		
A	3½	4	15	Improved color after 45 min.
B	4½	7½	7½	Color slightly improved; restrictor limits capacity.
C	2½	3	15	Improved color after 25 min.
D	1½	1½	15	Improved color after 50 min.
E	3	3½	15	Improved color after 45 min.

The temperature of the oil in each of the above tests was held constant at 160 F.

chemical and physical changes that take place. These changes are as follows:

1. Contamination with road dust.
2. Contamination with metal particles from wear or abrasion of engine parts.
3. Asphaltenes (partially oxidized oil).
4. Increase in oil acidity.
5. Dilution with the less volatile portions of the gasoline not burned in the combustion chamber.
6. Contamination with water formed by combustion of the fuel.

Since many manufacturers of filters maintain superiority in filter medias, filter aids, and design of construction, and since each does have points of merit, the most important factor is an accurate measure of the cleanliness of the oil filtered. That means that the methods used in determining cleanliness must be reliable.

The test apparatus as shown in Figure 1 was composed of a 6 in. diameter and a 12 in. diameter pipe welded to a plate forming a two gallon capacity reservoir for the oil, surrounded by a water jacket for temperature control. The filter was mounted above the reservoir and the oil was circulated by a suitable pump. (⅛ hp, 1140 rpm) A by-pass and pressure gauge was installed in the system to regulate the capacity and to indicate the filter resistance.

The test was conducted by using discarded motor oil for each filter and measuring the effectiveness by the quality of the oil recovered. One barrel of discarded oil supplied the source of material for all tests. The test of the filters was made by circulating six quarts of used crankcase oil in the test apparatus for two hours at 160 F. The analysis of the oil and comparative test data as shown in Tables I, II, III and IV establish the rating for each filter.

Viscosity

Viscosity, which is one of the most important properties of a lubricating oil, is a measure of resistance to

TABLE III

Comparative Cost and Construction

Comparative cost is based on a non-refillable unit as one, and all other units as a percentage multiple.

Filter	Cost	Refill cost	Filter dimension, in.	Construction comments
A	1	Non-fillable	4.3 diameter 5.81 long	Non-removable cartridge.
B	1.16	0.33	4.3 diameter 7.25 long	Has restrictor built in filter. Medium construction wall thickness .076 in.
C	2.28	0.43	4.7 diameter 7.87 long	Has tendency to leak around top if not securely tightened. Medium construction wall thickness .076 in.
D	2.38	0.28	4.9 diameter 8.87 long	Heavy construction wall thickness .115 in.
E	2.38	0.47	4.4 diameter 8.37 long	Has restrictor built in filter. Light construction wall thickness .040 in.

TABLE II

Analysis of Oil After Filtering

Filter	A	B	C	D	E	Unfiltered oil
Viscosity (Saybolt universal)						
at 100 F (Sec)	141	137	137	137	139	129
at 210 F (Sec)	44	44	44	44	44	44
Total sediment (per cent)	.04	.08	.04	.05	.06	.61
Free carbon (per cent)	.03	.08	.04	.05	.06	.50
Non-carbon sediment (per cent)	.01	.00	.00	.00	.00	.11
Neutralization number (mg KOH per g of oil)	.35	.34	.30	.23	.29	.53
Color N.P.A.	8	Black	8	8	8	Black

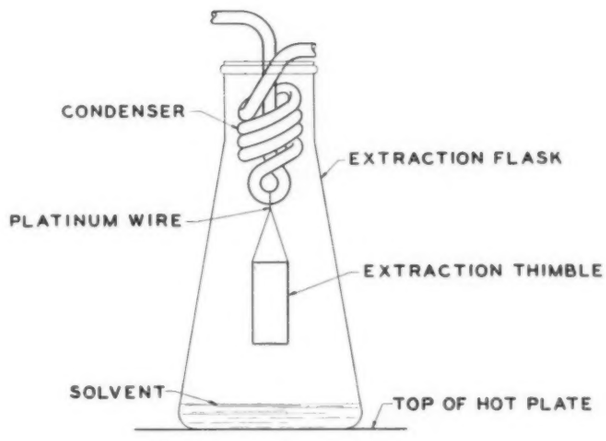


Figure 2 — Sketch showing apparatus for determination of sediment by extraction.

flow and is calibrated in the United States by the Saybolt universal viscosimeter. While the viscosity is important in the selection of new oils, it is the change in viscosity that is essential in the maintenance of oil, for it indicates oxidation, entrained solid particles or dilution.

Neutralization Number

The test for acidity is to determine the number of milligrams of potassium hydroxide necessary to neutralize the acid content in one gram of oil. This test is an important one because oil of high acidity is detrimental to surfaces of bearings and may be indicative of other chemical changes taking place in the lubricant.

Sediment

The sediment, or the foreign matter in the lubricant, can be measured either by extraction or centrifuging. The extraction method as shown in Figure 2 is used with a special alundum thimble to obtain the desired accuracy. This is a simple but conclusive method of testing oils for cleanliness only. The determination of sediment

TABLE IV

Oil Filter Comparative Rating

Rating	1st choice	2nd choice	3rd choice	4th choice	5th choice
Construction	D	C	B	E	A
Total sediment	A-C	D	E	B	.....
Non-carbon sediment	D-C-B-E	A	.....	.....	.....
Neutralization number	D	E	C	B	A
Color	C-D-A-E	B	.....	.....	.....
Initial cost	A	B	C	D-E	.....
Refill cost	D	B	C	E	A

is made by extraction with toluol through the special alundum thimble which is accepted as the standard for filtration. The combustible material is then determined and subtracted from the total sediment and the remainder considered undesirable non-carbon sediment.

If a lubricant maintains the desired ranges of viscosity with a low neutralization number, only traces of sediment and no dilution, it is quite evident that it will continue to give satisfactory service.

Practically all oil filters efficiently remove dust and metal particles until they become clogged, at which time the filter has completely lost its effectiveness in reducing wear on the engine by abrasion of foreign particles. As a safety feature the filter is generally installed with a by-pass even though the unit may contain a by-pass feature within the element. With this

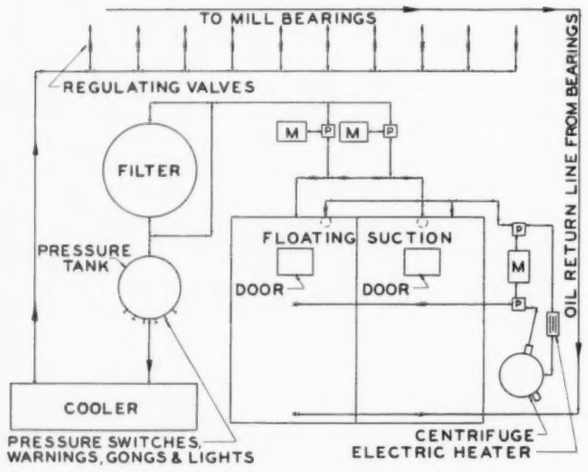


Figure 3 — Schematic arrangement of typical oil circulating system for rolling mills.

arrangement failure of the filter can not affect the flow of oil in the system.

The increase in acidity of oil may be corrected by adding fuller's earth, neutralizing clay, or equivalent chemicals to the filter media. In the event that abrasive, neutralizing earth is used, it is effectively retained in place by the addition of a binder which forms it to the desired shape. The neutralizing agent is always completely surrounded with an ample quantity of fibrous filter material. In many installations, the neutralization feature is not desired because of additives used in the oil for special purposes, in which cases the neutralizing agent is omitted in the construction of the filter. The reason for omitting the neutralizing clays is that they may remove any oxidation additives in the oil, thus defeating the original purpose of the additive. Oil filters containing cloth, felt, cotton, fiber, cellulose fiber, etc., if properly designed will remove the asphaltenes, and carbonaceous material as they form in the oil and retain or restore the color of the lubricant.

Dilution of crank case oil and cold water sludges are matters of concern on machines subjected to intermittent operation. In industry this dilution has not been encountered as a serious problem because the majority of equipment operates at a temperature sufficient to evaporate gasoline fractions and moisture.

It is possible to recover oil effectively by settling. One method is to place the lubricant in a large container where the height is greater than the diameter, and with valve connections on the side, the lubricant can be decanted after it has been allowed to settle sufficiently. A period of a month is ample time for the top half of the tank to clarify if moderate temperature is maintained. This method provides an economical recovery of the oil which is restored in color and which has a total sediment analysis as low as .02 per cent. It does not correct acidity but if oil recovered in this manner is subjected to a reasonable service period, the neutralization number should not be dangerously high.

The carbon which gives the oil a dark color can be settled or filtered out but cannot be completely removed by centrifuging. Thus the small capacity filters heretofore described and tested are effective and have a definite service in the maintenance of small oil-circulating systems.

Large Oil Circulating Systems

The problems involved in large oil circulating systems are fundamentally the same as those in small systems with the exception that a large quantity of oil requires filtration equipment designed for greater capacity.

The problems are occasionally solved either by design or by the proper selection of lubricants; but the potentialities of existing equipment and materials must be the first consideration. The condition under which lubricating systems can work efficiently varies greatly with the type of industry and the severity of various physical elements. A steel mill no doubt subjects its lubricants to the severest of operating conditions, some of which are as follows:

High pressures
High and low temperatures
Water contamination
Scale contamination
Rolling oil contamination
Aeration
Long service

Figure 7 illustrates a type of lubricating system for a five-stand, four-high, tandem, cold reduction mill with back-up rolls lubricated with a 2200 SSU mineral oil. This type of mill presents many problems which will be herein described. It is desirable to have an 8000 to 10,000 gallon storage tank with a partition separating it into two compartments, or individual reservoirs. It is well for the storage tank to be located in a ventilated basement, as shown in Figure 8, where it will be free from contaminating gases or mill dust and also will allow gravity flow for the return lines.

The heart of the circulating system is the pump, or pumps, taking the oil from the storage tank through a floating suction line approximately 18 in. below the surface and starting it on its way to perform its function

upon the mill. For a system such as described the pumps would be approximately 150 gpm capacity conveying the lubricant to filters of the metal-screen type with total filtering area of 180 sq ft. Filters of this type are effective and should receive sufficient attention so that they will not become clogged and allow pressure to build up to the extent that relief valves will open and by-pass the unit. This type of filtration has mechanical limitations in the size of particles that may be removed from large volumes of oil.

The next step is a pressure surge tank followed by water-cooling coils, maintaining a lubricant temperature of 100 to 105 F. The twenty bearings are serviced by pressure regulating valves with ½ in. by-passes as an emergency feature in the event of valve failures. The lubricant pressure maintained at the bearing ranges from 10 to 15 psi and is maintained as low as possible to hold to a minimum the oil loss by the piston ring type of oil seal.

It is desirable that the return lines be of sufficient size that there will be no difficulty in conveying the lubricant back to the storage tanks. The oil return line from the floating top back-up roll is occasionally made from flexible hose to accommodate for the movement of the roll. This design may be conducive to oil leakage because the flexed hose may restrict the flow of return oil and raise the level of the oil in the bearing chock above the oil seal, allowing the lubricant to leak from the bearing. In such cases, design may be corrected by the use of pipe connections from the bearing chock telescoping into the return line.

While loss of oil due to leakage is an important factor, the infiltration of contaminating fluids into the circulating system is also of major importance. Proper design of the water shed on the end of the back-up roll barrel aids in minimizing this problem. The best designs available in oil seal rings are none too satisfactory and these rings should be maintained in perfect condition, not only from an economic standpoint in loss of lubricant but in cleanliness of lubricant as well. The addition of neoprene rings to the ends of bearings as an aid in preventing the ingress of foreign elements has been found to be highly effective. When the oil has returned to the storage tank, it is theoretically ready to repeat the cycle. The severity of the service and mechanical conditions determine the additional maintenance that is required at this point.

In the event that there are large quantities of water or rolling oils entering the bearings and thus contaminating the lubricating oils it is then necessary to apply purification methods beyond the limits of the filters or settling tanks. Mechanical centrifuging is necessary in varying amounts depending upon quantities and types of foreign material ingressing into the system. The double compartment storage tank design is very convenient at this time because it allows the mill to operate on one compartment while the adjacent tank is undergoing recovery. A third standby tank is an ideal design but not found on older systems. Since it is necessary to heat the contaminated oil to approximately 160 F before centrifuging, it is not desirable to subject the lubricant to any more aeration than is necessary. Therefore, the entire tank of oil is heated and allowed to settle. The suction line of the centrifuge pump which draws from the bottom of the tank removes the water and most contaminated oil first, reducing the total time required to recondition the lubricant.

In the event that the water has remained in the system until a semi-permanent emulsion has formed, it is necessary to hold the tank at an elevated temperature for several days to allow the water to separate. It would appear that such methods of purification would be very desirable for any system where this condition has occurred. However, upon observing monthly analyses of lubricants working under such conditions, it is found that regardless of filtration or centrifuging, the sediment increases. This sediment may be in suspension in the oil, or deposited on the sides and bottom of the tank. When the percentage of sediment exceeds .1 per cent the most economical method of purification is to centrifuge all of the oil into one compartment and wipe the empty tank dry with rags. Any loose rust formation on the top or sides of the tank above the oil line should be removed and the surface coated with some of the bearing oil. The total quantity of oil is then passed through the centrifuge into the clean tank, allowing the second compartment to be cleaned in like manner. When the oil has again been divided into the two compartments, the cleaning process has been effected independent of the source of supply. Circulating systems involving large quantities of oil require at least monthly attention and often weekly inspection and service.

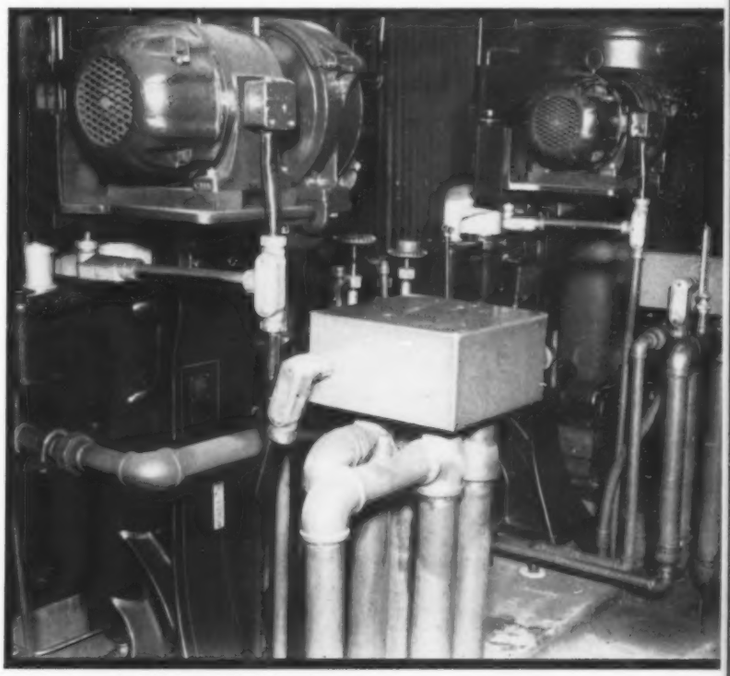


Figure 4 — Oil storage tanks should be located in clean, well-ventilated basement.

It is convenient to have a test tube centrifuge available for immediate checks on water and sediment con-

tent. It is also beneficial in determining when the system requires centrifuging and when it has received sufficient reconditioning. A monthly analysis showing viscosity, moisture, acidity and sediment is essential for an accurate and permanent record of the condition of the lubricant.

The increase of viscosity may indicate oxidation of the oil; it results in excessive sludging which affects the quality of the lubricant. If the viscosity decreases, there may be evidence that foreign fluids are contaminating the lubricant and immediate attention should be given before lubricating qualities are sacrificed.

If the monthly analysis reveals the presence of excessive moisture, centrifuging is necessary. While occasionally rolling mill systems may temporarily carry 20 to 25 per cent of water with no mechanical damage to bearings, it is desirable to maintain a figure of 1 per cent or less.

The sediment rating is the measure of the solids in the oil. Not all petroleum solids are harmful, but they are considered undesirable unless definitely identified.

The acidity measured in terms of milligrams of potassium hydroxide per gram of oil is indicative of the chemical stability of the lubricant in conjunction with the other test shown in the analysis.

Oil Reclamation

Used lubricating oil which has become so dirty as to need replacement may in many cases be restored to a condition equal to new oils in lubricating value and can be reused for its original purpose. This is a useful and important fact, but the necessary equipment and quantity of oil involved often makes the cost of reclamation prohibitive. The average industrial plant using many kinds of oil is not equipped with an extensive waste oil recovery department because the various types of reclamation for specific oils would require expensive equipment and highly trained personnel, the cost of which would readily exceed the savings. If one approaches the problem from a less complex standpoint and considers conditions existing in an average steel mill, a solution may be seen whereby not only a saving can be realized but a helpful hand extended to maintenance.

The first requirement of a waste oil recovery plant is a centrifuge, either portable or stationary, located in a room with sufficient storage tanks and heating facilities to accommodate the particular type of materials that are to be handled. A flexible arrangement which will allow the handling of various quantities of oil is desirable; for example, one 50 gal drum of salvage lubricant can be handled as easily as 5000 gal of another oil, providing the tank capacity and piping are arranged properly.

The source of salvage oil varies with the requirement of every lubricant. If, for any reason, there is oil leakage on a piece of equipment, either normal or accidental, the lubricant may find its way to the foundation pits. If the lost oil has not been contaminated with other mineral products, it can be removed from the pits and sent to the waste oil recovery plant where it has a definite salvage value. In many cases a mechanical purification by centrifuging is sufficient to put the lubricant back into service. Whether or not it will be used in its original application is determined by the individual circumstances of the operating equipment. The flexibility of the waste oil recovery plant to handle each lot of salvage oil as an individual case enables every lot to be recovered in varying degrees and returned to service. In the event a quantity of unknown oil of questionable quality is obtained at the recovery plant, it first receives mechanical purification by centrifuging and then the physical properties are checked. Its return to service is dependent upon the existing physical properties and the requirements of the equipment on which it is to be used. In most plants there are some all-loss systems where low quality oils can be used with safety. The waste oil recovery plant serves as an economical source of oil supply for various types of table rolls, furnace bearings, heavy-loss hydraulic systems, slushing applications, etc. The cost of mechanical purification ranges from one to two cents per gallon with a minimum recovery value of the lowest priced lubricating oil.

A classification of new lubricants with a code number descriptive of the material is beneficial in identifying salvaged oil. The following definitions and key to one classification system in use will illustrate the fundamentals applied in segregating lubricants by types.

Class Symbol	*Class Name*	*Measure of consistency*
M	Mineral oil group	Viscosity SSU 100 F
C	Cylinder oil	Viscosity SSU 210 F
P	Protective coating oils	Viscosity SSU 100 F
N	Gear shield lubricants	Viscosity SSU 210 F
S	Soluble and cutting oils	Viscosity SSU 100 F
EPF	Extreme pressure fluid lubricants	Viscosity SSU 210 F
Misc.	A number with the absence of a letter symbol indicates the miscellaneous group.	

All materials are classified and designated by a code which identifies the type of lubricant and viscosity or consistency characteristics. The letter, for example, indicates a group or class of lubricants, and the numerical value which immediately follows is indicative of the consistency.

Mineral Oils

Materials assigned the prefix "M" are straight petroleum products with no compounding. The Saybolt universal viscosity measure of consistency at 100 F is applied, allowing normal production range limits; for example, a 100 sec viscosity oil would have an allowable range of 95 to 105 sec.

The low limit of the scale is considered 40 sec and the high limit 4000 sec. Any material with a lesser or greater number can be regarded, for practical purposes, as outside the limits of the Saybolt universal instrument at 100 F. For example, a mineral oil with a code number of M-500 would be defined as a straight mineral oil with a viscosity of 500 sec at 100 F.

Cylinder Oils

Lubricants with a prefix of "C" are high viscosity mineral oils which may or may not be compounded. This group includes animal fat compounding for steam cylinder applications or straight cylinder stocks, including steam refined materials. Since this class of lubricants is very viscous the measure of consistency is given in Saybolt sec universal at 210 F. Thus, an oil represented by a code number of C-145 is a cylinder oil with a viscosity of 145 sec at 210 F.

Gear Shield Lubricants

The lubricant used on open or closed gears requiring an adhesive and viscous material is commonly termed a gear shield. It may be a residuum cut back with oil or a black oil compounded with such materials as soap or graphite. The code number N-350 would represent a lubricant suitable for hot strip mill table gears with considerable leakage or similar rough machinery requiring a consistency of 350 sec at 210 F.

Protective Coating Oils

Oils used for the prevention of rust are frequently mixtures of mineral solvents and animal or vegetable solutes. Drawing compounds are often designed in conjunction with rust preventives and are, therefore, considered a field of development separate from lubrication and are herein classified as protective coating oils. The number P-55 represents a mineral solvent with a viscosity of 55 sec at 100 F, but carrying an inhibitor designed for the prevention of rust. It is possible to use the product of the waste oil recovery plant for purposes of protective coating, such as requirements for storage within the plant.

Soluble and Cutting Oils

The group of emulsifying oils are prefixed by the letter "S." This class includes all soluble oils for use as coolants, regardless of method of manufacture. Cutting oils, not emulsive but used for grinding or thread cutting, are also included. The viscosity measure of consistency is of little value for these materials but is given at 100 F for standardization purposes. S-185 is the code title for a material measuring 185 sec viscosity at 100 F used for a coolant or cutting lubricant. The detailed specification should be studied for the specific applications. It is seldom possible to recover a soluble oil because in most cases it emulsifies with water and is lost or the cost of recovering would be prohibitive. However, where soluble oil is used as a rolling coolant, the solution is salvaged by allowing the entire mixture to settle and removing the soluble oil and water in the form of a clean milk colored mixture.

Extreme Pressure Fluid Lubricants

The initial letters "EPF" form the prefix symbol for the classification of extreme pressure lubricants. This type of lubricant contains compounds of lead, sulphur, or other materials for the purpose of increasing the film strength. Extreme pressure lubricants were designed for application on pinion stands, screws, and similar equipment, where the unit area pressures that must be withstood are greater than the film strength of conventional lubricants. The code number EPF-110 would indicate an extreme pressure fluid lubricant with a viscosity of 110 sec at 210 F. This group is measured at 210 F because some of the materials are very viscous and would have numbers too high to measure accurately at 100 F.

When extreme pressure fluid lubricants are received at the waste oil recovery plant they are centrifuged and tested for film strength. If the material proves inferior for the original service, it is issued to equipment where a salvage value will be realized according to the qualities still remaining in the lubricant.

Miscellaneous

The materials under the heading of miscellaneous are those that do not fall into any of the classes heretofore defined. Many of these lubricants are specialty products designed for a particular application, which should be known before making recommendations. The miscellaneous group is designated by numbers with no letter prefix. These numbers have no significance other than for purposes of identification. It is seldom that materials in the miscellaneous group involve recovery problems.

The second method for the reclamation of oil is by chemical treatment, which of course produces a more desirable product with a higher recovery value. The most common chemical treatment is the one used at the refinery in the production of new oil. Neutralizing clays or activated earths are used in both percolation and contact methods.

The percolation method is too costly for reclamation purposes and is mainly used by refineries. The most common method of neutralizing with clay is the contact process, there being several patented designs of reclamation units. Although neutralization occurs, the process also effectively decolorizes the oil. The spent oil is placed in a treating chamber free from moisture and heated to 300 to 500 F where the earth is allowed to come into contact by being suspended in the fluid at the elevated temperature. The oil and clay slurry is then allowed to cool sufficiently for filtering and is passed through a filter press, paper serving as a filter media, and the removed earth acting as a filter aid. The resulting product is a neutralized lubricant with color restored and all decomposed hydrocarbons removed. While the oil quality is higher, the reclamation cost is also greater, ranging from five cents per gal upward.

The factors involved in the more technical methods of reclamation are quality of oil, cost and capacity of reclaiming equipment, and operating personnel. In the majority of organizations there is not a sufficient quantity of oil to justify a full time operator for reclamation equipment; but if there are oil circulating systems in operation, the maintenance attendants for the circulating oil should be trained in oil testing and capable of operating a waste oil recovery plant, thus creating sufficient work for a full time personnel.

DISCUSSION

C. E. S. EDDIE, Lubrication Engineer, Great Lakes Steel Corporation, Ecorse, Michigan

MAURICE RESWICK, Lubrication Engineer, Standard Oil Company of New Jersey, New York, New York

GEORGE H. KAUFFELD, JR., Special Representative, De Laval Separator Company, Pittsburgh, Pennsylvania

F. E. ROSENSTIEHL, Supervisor, Technical Service, Texas Company, New York, New York

C. A. BAILEY, Assistant to Divisional Superintendent of Maintenance, Sheet and Tin Mills, Carnegie-Illinois Steel Corporation, Gary, Indiana

C. E. S. EDDIE: This paper involves, as the author presents his case, economic limitations. The basic fundamental fact is that if an oil is maintained in good operating condition in a system, or in a given piece of equipment, reclamation (so called) is not necessary.

The investigation refers to tough service in lubrication for the internal combustion engine; probably the severity of diesel service for the average plant can motivate this particular point. Some time ago we installed a system of purification for the diesel fleet that is doing a very satisfactory job.

Prior to this installation, detergents and inhibitors were used to limit the build-up of detrimental additions to the oil without success, in the hopes of warding off evil things that happen to the crankcase oil, under the temperature-pressure conditions which exist. The contact earth type method of purification is now being used, utilizing common refinery earth. Regulated periodic or sweetening procedure is an acclaimed success by the operating personnel in our maintenance costs, and has effected in principle the fellow who was required to foot the bills for labor rates and replacement parts.

The keynote of this paper is undoubtedly "cleanliness." The author has to be commended on this important principle. The removal of decomposed hydrocarbons, non lubricating volatiles, dilution, colloidal carbons, etc., is a displaced necessity, and produces in effect a high quality oil. There is no better plan for long life, than to keep the blood stream clean. The use of neutralizing clays or activated earth does a thorough job, when handling contaminated oils in 24 hr service.

Referring to the section dealing with enclosed back-up roll oil system for continuous rolling, we have found that removal of absorbed water in this cycle is more economically effected by the gravity settling, and blowing method. The exhauster fan discharge from batch tanks, is designed with an oil separator and vapor condensing outlet. The loss of oil involved in accelerating the water separation by centrifuge is not economical, — unless the separated emulsion can be relieved of the entrained oil content, which did in our particular case average 17 per cent of total separation.

The flow of oil through the centrifuge bowl must be suited to the saturation, and the amount of contamination; this involves too much of the human element in operation, and for the varying percentages of water, feeding too rapidly results only in partial separation, and a consequent re-cycle.

The batch tanks are thermostatically controlled to maintain a uniformity in heating. After the blowing period is complete, the batch is allowed to cool by cutting off the heat from the tank. Convection would otherwise interfere with the remaining water in gravity settling. The water layer at the bottom of tank is then removed. In maintaining a good steam emulsion number, water separates very rapidly, even with a 2300 sec at 100 F oil.

In our waste oil recovery department, we have not found any quantity or specified lubricating oils recovered to be prohibitive, even in recovery of oxidized oils for slushing and coating purposes. The highest cost for heavily contaminated oil does not exceed 8½ cents per gal, and averages 5 cents per gal by the contact method.

Referring to the salvaged oil part of the paper, this was for some time a problem, in justifying a full time operator for this equipment; however, recently a well designed skimmer has been installed in mill scale pits to recover floating oil in the event of a pipe break in any of the main systems. The operation of this equipment, presettling of the oil in gravity separation tanks at the pits, and after decantation is then transferred to recovery plant.

The classification and code numbering system suggested by Mr. Bailey for salvaged oil can be profitably adopted by many plants.

MAURICE RESWICK: I like Mr. Bailey's paper for its general coverage of the subject and its conciseness. The principal divisions of this paper are as follows:

1. Sources of contamination of lubricants.
2. Rapid methods for determining the extent of contamination and degree of deterioration of oils.
3. Means of reconditioning of oils as a maintenance problem.
4. Reclaiming waste oil.
5. The designation of all kinds of oils and greases by convenient code numbers.

Mill dirt and water are the worst enemies of oil in a steel plant. Dirt causes abrasion of the lubricated parts of machinery, accelerates oxidation and acidity, and promotes emulsification with water. River water used in steel mills for cooling is notoriously known for impurities, being high in sulphur and iron compounds and will combine with the best oils.

Prevention of contamination with water and mill dirt is of utmost importance. The seals on the bearings should be checked and reconditioned at frequent intervals and the direction of the stream of water on the rolls should be such that no water is permitted to enter the bearings under pressure.

Superfluous water and steam pipes should be eliminated in all parts of a circulating system, particularly in the settling tanks and filters. Most installations do not require oil heating or cooling coils, but usually they are equipped with such piping, and it is advisable not to connect them. Sooner or later a leak may develop either in the steel pipes or in the connecting valves and contaminate the oil. Such superfluous piping also interferes with cleaning of tanks.

Adequate settling tank capacity is the best insurance for maintaining circulating oil in good conditions. These tanks should be of double compartment design, so that the oil in one compartment can be maintained at a temperature of 140 to 160 F for several days to permit the settling out of the water, dirt, and sludge. The clean oil may then be transferred to the other compartment, after which the first compartment may be thoroughly cleaned. It is to be regretted that such facilities do not generally exist at present on many of the newer types of rolling mills.

The constant servicing of circulating oil is a regular maintenance problem, but the reclamation of oil in a centralized department is of doubtful economy. The author answers this question himself in his statement that in the majority of plants there is not a sufficient quantity of oil involved to justify full time operation of reclamation equipment.

At best, reclamation of oil in an industrial plant is limited to mechanical means of dirt removal and dehydration by settling out under heat, filtration and centrifuging. Chemical treatment for the removal of acidity and filtration through clay, and the blending of oils for uniform viscosity cannot be carried out efficiently in a plant whose main concern is the manufacture of steel products.

In every steel plant there exists a variety of uses of petroleum products of secondary quality, and it is on such secondary applications where a barrel or two of oil that has outlived its usefulness on primary applications can be used to best advantage and utmost economy.

GEORGE H. KAUFFELD, JR.: I would like to comment on a few statements made during the discussion which appear to me to have been in error.

The first statement was made by Mr. Eddie who mentioned that it was uneconomical to centrifuge oils for the removal of moisture because of the entrained emulsification that might be there. This statement might be true if the discharged emsulsification is thrown away, though I might point out to him that the emulsified oil can be entirely reclaimed by a very simple process, and in fact, is being reclaimed in some plants by the same process.

The other statement which I would like to comment on was that made by Mr. Reswick in which he recommended that all steam piping be eliminated from oil reservoirs and that water be disconnected from existing oil cooling equipment. Evidently Mr. Reswick is not familiar with the general design of lubrication systems since in making that statement he is putting a tremendous load on the designer of the lubrication equipment, as well as on the mill builders, due to the variable temperature conditions that might be encountered in any particular lubrication problem. For instance, you cannot economically design a lubrication system to handle 2400 SSU oil at 100 F for normal 100 F temperature conditions and expect your pumps, filters and piping to handle that oil at say 50 F at which temperature the viscosity has increased to a point above the pump powering limits, in addition to which if pumping were possible, line pressure drops would be excessive. On the other hand, if you design the equipment for the low temperature condition and actual operation is attempted at temperatures say of 150 F, the viscosity at this temperature would involve pump slippage resulting in reduced capacity, to say nothing of the danger of lubricating bearings and gear mesh points at this viscosity. It is therefore definitely necessary for the proper lubrication of equipment, to control oil supply temperatures to within certain predetermined limits by either heating, cooling, or a combination of both, all of which are design limitations which set the requirements for the particular job to be done.

F. E. ROSENSTIEHL: Mr. Bailey has covered this subject very ably. One point which I would like to comment upon is the statement he made to the effect that neutralization number is an indication of the effect of the lubricant on bearings. This is not strictly in accordance with our experience. The neutralization number of a used oil merely measures the quantity of organic acids present, and does not indicate the nature of these acids. We have seen many used oils with neutralization numbers as high as 4, 5 and even up to 7, which have had no effect whatsoever on metallic parts. On the other hand, we have seen used oils with neutralization numbers as low as 0.5 where, due to the nature of the acids formed, attack of metallic surfaces has occurred. The rate of increase of neutralization number is of value in determining the rate of change which the oil is undergoing through service. We are more concerned when an oil shows a rapid rise in neutralization number than when the oil shows a gradual increase.

C. A. BAILEY: In connection with the neutralization number, I agree with you entirely upon that statement, but I think you will agree with me that if you have a high neutralization number you are going to watch it. If I have a high neutralization number, my oil supplier is going to know it, and I am going to watch that system periodically.

F. E. ROSENSTIEHL: I was particularly interested in Mr. Bailey's statements regarding reclaiming of gear shields and viscous lubricants of this type, and I would like to inquire just how such materials are reclaimed.

C. A. BAILEY: We have a procedure in which no oil is to be discarded by an operating department. If any one has a barrel of oil that is a disposal problem to him, he is instructed to call the transportation department and have the oil sent to the waste oil recovery plant at the recovery department's expense. Then it is the problem of the waste oil recovery plant to either recover or dispose of it. In some cases we are able to take a very viscous material and thin it with something that is lighter, depending upon individual circumstances and then it is the problem of the recovery plant to find a place to use the material, which might be anything from a fairly important machine to greasing skids. If it is not possible to find a secondary application for the material it is then a disposal problem for the waste oil recovery plant.

BLOOM and BILLET Heating Furnaces

By M. H. Mawhinney, Consulting Engineer, Salem, Ohio

PRESENTED BEFORE A. I. S. E. ANNUAL CONVENTION, CLEVELAND, OHIO

▲ THE purpose of this paper is to discuss recent developments in the design of new furnaces and in the improvement of existing furnaces for the heating of billets and blooms, which are assumed to include steel pieces in sections from about 2 in. square to about 20 in. square and in lengths from about 3 ft to about 30 ft.

The heating is in all cases assumed to be for the purpose of softening for a rolling or other forming operation, and the problem is to heat each piece with a maximum uniformity of temperature and with a minimum amount of damage to the steel surface.

Uniform heating has been a requirement for many years, but the emphasis on surface damage is of more recent origin and has been responsible for the majority of the improvements in design of these furnaces.

The principal factors involved in a discussion of this type of furnace include atmosphere and temperature control, fuels, and handling of the heating steel; and a general discussion of these factors should logically precede any discussion of the various furnace types in this classification.

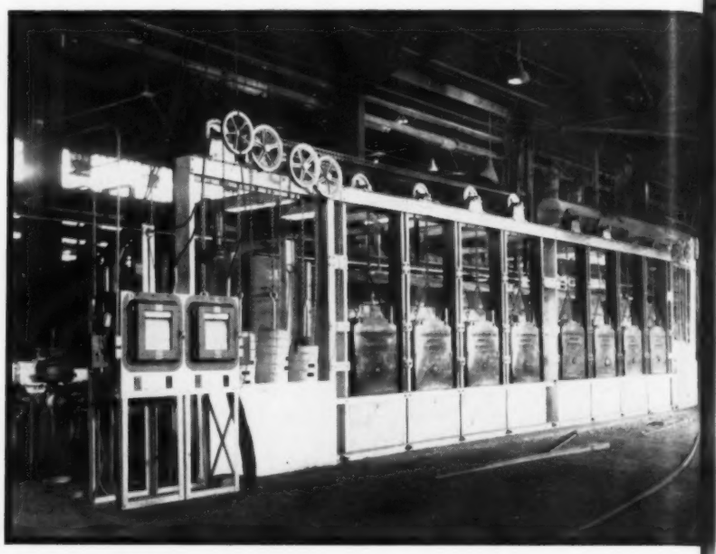


Figure 1 — Batch type billet heating furnace.

Atmosphere and Furnace Temperature Control

One of the most important factors in modern steel making is the decarburization of the steel when heated for the various steps in its manufacture. This decarburization is simply the loss of carbon from the surface of the steel as the result of reaction with the hot gases which surround the steel while heated, and the quantitative determination is made either by measuring the affected depth under a microscope or by analyzing successive cuts from the surface. The other phenomenon which bears a direct relation to the net amount of decarburization is scaling (loss of iron by oxidation), which progresses simultaneously with decarburization and must be considered together with decarburization.

The atmosphere in a billet or bloom heating furnace under positive pressure depends upon the fuel-air ratio and contains varying amounts of carbon dioxide, nitrogen, water vapor, hydrogen, carbon monoxide (from a deficiency of air or poor mixing of fuel and air), and oxygen (from an excess of air or from poor mixing). All practical furnace atmospheres are oxidizing in their effect, since it has been demonstrated that an impractical proportion of 15 per cent of carbon monoxide must be present in order to prevent oxidation, or scaling of the steel. The other source of oxygen in a heating furnace is in free air entering the furnace as the result of a draft. The oxidizing or scaling agents in order of their importance are oxygen (nascent form entering through the burners with the fuel), free air, water vapor, and carbon dioxide.

Decarburization is caused by hydrogen-water vapor combinations, free air, and carbon dioxide, in order of their activity. The hydrogen-water vapor combination, which is much more active than the other sources of decarburization, cannot exist in an atmosphere resulting from good combustion with a slight excess of combustion air, and the free air, which is second in activity, can be eliminated by a positive pressure in the furnace. These facts, together with the fact that scaling physically removes part of the decarburized surface, account for the desireability of a somewhat oxidizing atmosphere in furnaces for the heating of alloy steels.

Other factors affecting scale and decarburization include:

1. *Fuels* — The relative quantities of hydrogen, water vapor, and carbon dioxide produced per unit of heat released vary with different fuels and, consequently, affect their activity in producing scale and decarburization.

2. *Furnace Pressure* — Positive pressure is desirable at all times to exclude free air, which is more decarburizing than it is oxidizing.

3. *Furnace Temperature* — Temperature in the fur-

nace should be a minimum to reduce the amount of both scaling and decarburization.

4. *Fuel-Air Ratio* — This determined the atmosphere in the furnace. Excess air is desirable in most cases.

5. *Type of Burners* — Thorough mixing of fuel and air is desirable where decarburization is important.

6. *Amount of Reduction* — This refers to the amount of reduction in area and corresponding increase in surface area which is applied to the billet or bloom after heating, as the result of the rolling or forming operation. The decarburization is measured on the rolled section,

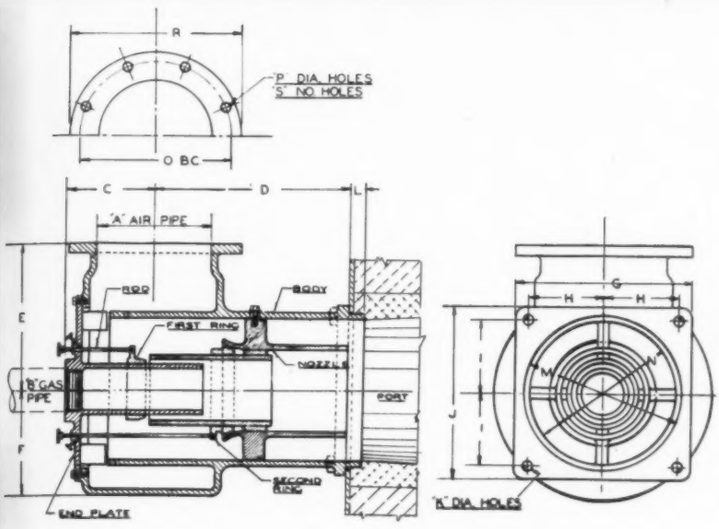


Figure 2 — Typical luminous flame burner.

and therefore, a large amount of reduction will decrease the amount of finished decarburization.

7. *Time at Temperature* — This is a very important factor, because the amount of both scale and decarburization is proportional to the time of exposure to the furnace gases.

8. *Analysis of the Steel* — Steels vary widely in their susceptibility to both scaling and decarburization.

Fuels for Heating Furnaces

Furnaces for the heating of billets and blooms in the steel mills are fired with every form of known fuel, in contrast to many of the finishing furnaces which must utilize fuels of high "form value" (clean gases and light oils). This is mostly because the quantities of fuel are high in heating furnaces and because the requirements of steel surface control have so far not been as exacting in heating furnaces as they have in furnaces for final treatments (annealing and heat treating).

Theoretically, the value of a fuel for controlled atmosphere heating varies inversely with its hydrogen content, because the hydrogen forms both the free hydrogen and the water vapor of the hydrogen-water vapor combination which is so actively decarburizing. Practically, however, this rule cannot be strictly followed because of the varying form values which offset the hydrogen content in some cases. For example, natural gas is much higher in hydrogen content than coal but its form value permits so much more accuracy in ratio and temperature control that it is preferable as a fuel in most cases. The same disadvantage applies to raw bituminous producer gas which is low in hydrogen but difficult to control. Various common fuels with the approximate percentages of water vapor in the products of perfect combustion in each case are as follows:

Fuel	*Per cent water vapor by volume in products of perfect combustion*
Blast furnace gas	None
Coke	None
Bituminous coal	6.7
Raw producer gas	6.9
Tar	6.9
Anthracite producer gas	9.6
Fuel oil	12.1
Butane	14.4
Natural gas	17.5
Coke oven gas	19.7
Artificial gas	21.8

Handling Methods

The broad division of handling means is into two classifications: in and out of batch type furnaces, and through continuous furnaces; and the first specific problem in the selection of furnaces for billets and blooms in any case is the choice between these two handling methods.

In general, the continuous furnace is more efficient, both in fuel economy and in labor required for operation, where it is applicable; but when applied in the wrong place it can easily become a "white elephant" and the temptation to install it must be resisted.

For strictly continuous operations involving pieces over 15 feet in length the continuous furnace is almost a foregone conclusion, which includes slab furnaces for continuous strip mills, billet furnaces for continuous rod mills in the wire industry, billet furnaces for many types of tube mills, and for those bar and merchant mills where relatively large orders can be rolled continuously.

The batch type furnace is unavoidable in many tool

Figure 3 — Auto floor charger for handling billets.

TABLE I

Furnace type	Fuel	Time in furnace, hr	Maximum depth of decarburization, of rolled section, in. from the surface
Regenerative	Producer gas	1	.007
Natural draft	Bituminous	2	.014
	Coke oven gas	1	.018
		2	.036
Regenerative	Coke oven gas	1	.012
Forced draft		2	.024
Direct fired	Coke oven gas	1	.009
Burners		2	.018
	Natural gas	1	.006
		2	.012

TABLE II

	Example I	Example II
Type of steel heated	Tool	Carbon
Number of furnaces	2	2
Size of furnaces	5 ft x 12 ft	18 ft x 36 ft
Total hearth area, sq ft	120	1296
Furnace charges in 8 hr turn	7.6	9
Size of billets or blooms	2 in x 2 in.	8 in. x 7 in.
Number of pieces in furnace charge	40	30
Weight per piece, lb	60	1305
Lb heated per hr	2280	44,000
Rate, lb per sq ft hearth per hr	19.0	34.0

TABLE III

	Example I	Example II
Product heated	Billets	Blooms
Size of pieces, section and length	4 in. x 4 in. x 10 ft	12 in. x 12 in. x 10 ft
Size of furnace	13 ft x 42 ft	14 ft x 61.5 ft
Hearth area, sq ft	546	860
Average production, lb per hr	23,500	50,000
Pieces per hr	40	10
Pieces in furnace	120	60
Heating time, hr	3.0	6.0
Rate, lb per sq ft per hr	43.5	58.2

Figure 4 — Charging machine for handling large billets and blooms.

steel mills and in alloy steel mills where small orders from short billets of many different grades must be rolled with frequent roll changes. This group also includes the handling of chunky billets and blooms for some piercing operations, which pieces cannot be pushed in large quantities, and for many hammer and press operations which are not continuous in their method of operation.

The third and difficult classification includes those operations for which the heating can be accomplished in either manner, but in which a careful analysis with an understanding of all of the factors will disclose an advantage for one or the other method of heating.

A detailed discussion of each of the two types of furnaces will assist in this decision.

Batch Type Furnaces

Batch type furnaces may be divided into three principal types from the standpoint of heat application, which are regenerative with natural draft, regenerative with forced draft, and direct burner fired, and the decarburization as well as the scale produced is largely influenced by the method of heat application.

The tabulation (Table I) shows the average values for depth of decarburization of carbon steel after a reduction in sectional area of 300 per cent from rolling. The figures given are for heating periods of 1 hr and 2 hr in the furnace, and were taken from graphs prepared from many tests involving many different periods of time and from which it was found that the depth of decarburization is proportional to the time. The figures are also for several fuels and for the three different types of heat application listed above. All tests from which the tabulated average figures were derived were under actual mill operating conditions, or, in other words, the tests were of bars rolled for commercial orders.

The capacity of a batch type furnace, such as shown in Figure 1, is determined by the hearth area, and the usual rate of production from furnaces for billets and blooms is between 20 and 35 lb of steel heated per sq ft of hearth area per hr. This figure is based upon the average amount heated for the mill (actual mill production will be less depending upon the yield) which is the monthly furnace production divided by the furnace operating hours in the month, including all delays, roll changes, and similar down-time. This is an important point and care must be taken in determining the average production if furnaces of the proper size are to be obtained.

For most mill operations, the maximum production in any 1 hr of the month is from 2 to 2½ times as great as the average hourly rate determined as described above. For example, a mill rolling an average of 15 tons of steel per hr can produce in any 1 hr as much as 35 tons.

Having determined the true average pounds of steel to be heated per hr, the required hearth area is determined by dividing this figure by the allowable heating rate. The minimum rate of 20 lb per sq ft per hr applies for small billets and for alloy steels where some chilling of the furnace is required before charging or where slow heating is necessary to prevent cracking of the steel. The high rate of 35 lb applies to large blooms where fast heating is permissable. The range given covers almost all conditions for rolling. In the case of forging, some furnaces are pushed at rates as high as 50 lb per sq ft per hr, but it is the author's belief that this practice is to the detriment of both the steel and the furnace. The tabulation (Table II) has been prepared to show two typical examples which illustrate the extremes in the operation of batch furnaces for rolling mills.

The time in the furnace for batch type furnaces varies between about 1 hr and about 3 hr in normal operation, which time depends upon the size and type of steel, and every effort must be made to keep this time to a minimum where surface conditions are important. Where decarburization is particularly important it is advisable to empty and recharge the furnaces rapidly in the event of an unexpected breakdown of equipment or other delay.

Burners for gas fired furnaces are usually of the luminous or long flame variety to obtain a "soft heat" and a maximum of temperature uniformity. A typical burner of this type is shown in Figure 2. For smaller furnaces heating tool steels or small alloy billets with low subsequent reductions and low decarburization specifications, a better degree of mixing is desirable which can be obtained by the operation of luminous burners at maximum rate of premix or by the use of blast type burners.

Flues in batch type furnaces are generally in the end walls or in the roof. Some ports should always be provided in the ends at the hearth level to keep the

corners hot. Ordinarily, an extra billet can be charged at each end when such ports are provided, and correspondingly greater production obtained. Stacks are not necessary to the operation of batch furnaces, but are sometimes provided to remove smoke and gases from the mill building. Greater care is necessary in providing furnace pressure when stacks are used because of the excessive draft, and hoods are always preferable to stacks for this reason. The flue area required in this type of batch furnace is about 6.3 sq in. per sq ft of furnace hearth.

The fuel required in batch type furnaces for billet and bloom heating is between 4.0 and 5.0 million Btu per ton of steel heated. The lower rate of production with small billets of alloy and tool steels is partially offset in its effect on fuel economy by the lower temperature at which this material is rolled.

A variety of handling machines are available for use with batch furnaces. With small billets the handling is frequently manual or by means of a peal or tongs suspended from a monorail. For larger pieces up to about 5000 lb an auto floor charger, such as is shown in Figure 3, can be used to charge furnaces up to about 10 ft deep. These chargers are served with electricity through a cable and reel, and operate on any flat floor between the furnaces and the mill or hammer. For larger blooms and billets and for furnaces of greater depth, larger auto chargers or the mechanical chargers operating on rails in front of the furnaces are usually used, as shown in Figure 4.

The soaking pit type of furnace is a variety of batch furnace which should be mentioned, because this type is occasionally used for blooms as well as ingots. The use is not common because most blooms vary too widely in section and length for convenient charging in vertical position and because the charging machine and cover operation of the pit type furnace is excessively costly.

Existing batch type furnaces in steel mills very frequently include one or more of the following correctable faults:

1. Regenerative firing which by its nature is difficult to operate with controlled atmosphere, unless forced draft is applied.
2. Stacks which create excessive draft and which are unnecessary on any batch furnace. Hoods are preferable where waste gases must be removed.
3. Lack of insulation to conserve fuel.
4. Lack of temperature, fuel-air ratio, and pressure control.
5. Excessive maintenance, usually from inadequate door and door frame design.
6. Loss of time from inadequate handling facilities.
7. Lack of scheduling to insure minimum heating time in the furnace.

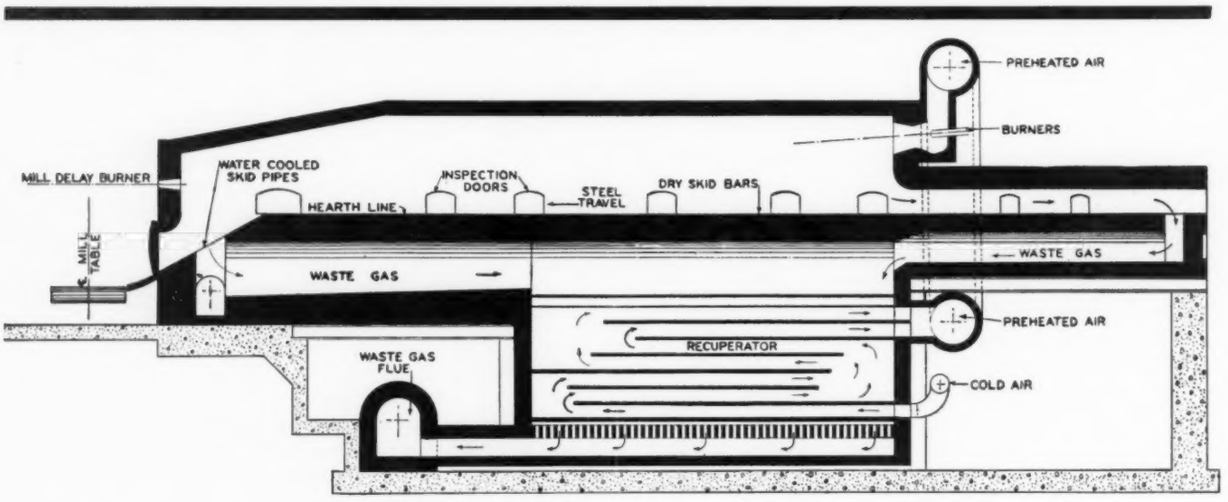


Figure 5 — One form of continuous billet furnace with zone heating.

From observation of many batch type furnaces in the steel mills it is quite evident that there is much room for improvement in their physical condition and in their operation, and the principle improvement will usually be accomplished by attention to the above factors, with provision for their correction.

Continuous Furnaces

Decarburization is generally less in continuous furnaces than in batch furnaces, when the continuous furnace operates without delays. However when delays occur without special provision for controlling the temperature in the zones of the continuous furnace, then the decarburization can easily be greater than in the more flexible batch operation with small charges in different furnaces.

The following is a tabulation of decarburization depth found in rolled sections from billets heated in continuous furnaces with a 300 per cent reduction in area from rolling:

Fuel	Time in furnace, hr	Maximum depth of decarburization in. from the surface, after rolling
Producer gas		
End discharge furnace	1	.005
	2	.010
Natural gas		
Side discharge furnace	1	.003
	2	.006

This tabulation also shows the bad effect of end discharging, since the decarburization is greater in this type furnace with a fuel which is normally better than natural gas.

The size of continuous furnaces must also be determined on the basis of average production over a month period or more. On such a basis, the allowable heating rate is from 40 to 60 lb of steel per sq ft of furnace hearth per hr. In a furnace determined in this manner, the maximum rate for any 1 hr will sometimes be as high as 80 or 100 lb heated per hr per sq ft of hearth. The variations in hearth rate are caused principally by the allowable speed with which different grades of steel can be heated without damage, or by the ability of different types of steel to absorb heat. Average rates of heating of billets and blooms in typical continuous furnaces are shown by the tabulation in Table III.

Various designs have been developed for the application of heat in continuous furnaces for billets and blooms. For thicknesses of stock up to and including 4 in., the top fired furnace is the usual choice, with heat applied to one side of the billets. The classic arrangement is with burners at the discharge end and flues to the stack at the charging end, but many variations have recently been devised to cope with the increasing demand for minimum scale and decarburization of alloy steels. These include firing two ways from the center, charging end as well as discharge end firing, and various arrangements of intermediate by-pass flues to the stack, all in order to control the temperature in the heating and soaking zones independently. Figure 5 shows one such form of continuous furnace.

Burners of the luminous type are preferred for gas firing of continuous heating furnaces and steam atomizing burners with mechanical secondary air are the best choice when firing with oil or tar. Automatic temperature control, fuel-air ratio control, and furnace pressure control are all desirable when heating any steels which require accurate control of heat application and atmosphere.

The method of discharging of the slabs, blooms, or billets is of prime importance in the control of atmosphere. End discharging by gravity which is attractive because of its simplicity, should be avoided in all cases where atmosphere is important, because with an open end the control of furnace pressure is so difficult that the infiltration of air at hearth level cannot be entirely avoided. Side discharge with a handling machine operating through the floor or with a discharge pusher is preferred in all cases.

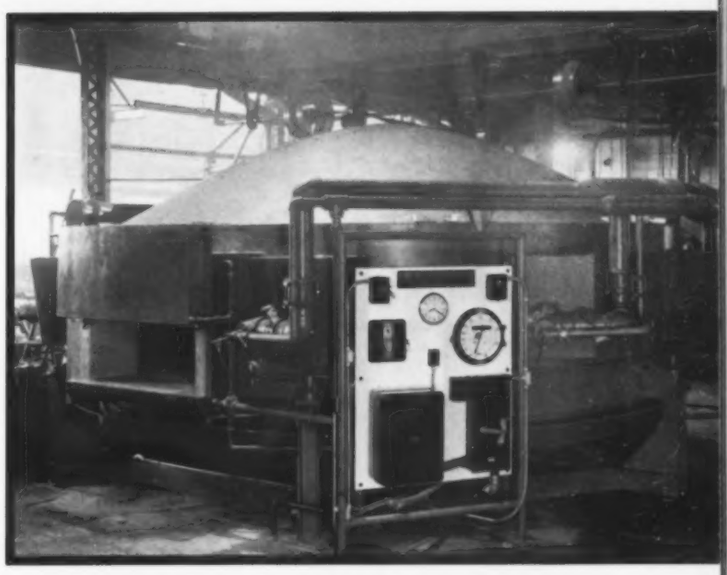


Figure 6 — Typical rotary hearth furnace for small billets.

The average fuel economy in continuous furnaces is between 1.2 and 3.0 million Btu per ton of steel heated, the variation depending mostly upon the heating rate, the tightness and the insulation of the furnace, and the control of the stack draft. The latter factor is particularly important, because if the draft is not controlled a great deal of the heat is carried into the flues and the stack.

For the heating of small billets, particularly those now used for shell manufacture, the rotary furnace shown in Figure 6 and similar furnaces are popular, because they will handle short pieces which are difficult to push satisfactorily. This type of furnace should be limited to a heating rate of about 50 lb per sq ft of hearth area per hr, because excessive forcing will result in liquid slag and resulting difficulties with the seals around the rotating hearth.

There are tremendous possibilities in the rehabilitating of existing continuous furnaces to better meet modern demands. A large percentage of these furnaces suffer from one or more of the following difficulties:

1. End discharge, with excessive air at hearth level.
2. Old, burned-out recuperators short circuiting combustion air to the stack and causing fuel-air ratio control to be impossible.
3. Excessive stack draft.
4. Booster burners for maximum production which are used unnecessarily at intermediate and low rates of production.
5. Lack of zone control to prevent overheating during breakdowns and other delays.
6. Excessive maintenance resulting from incorrect roof lines.

In conclusion, it may safely be stated that the heating facilities in the nation's steel mills can be greatly improved and increased somewhat in capacity by attention to modern knowledge of this subject, because the facilities for billet and bloom heating have been neglected to a greater extent than is the case for furnaces involved in subsequent heating operations.

DISCUSSION

E. E. CALLINAN, Combustion and Refractories Engineer, Timken Roller Bearing Company, Canton, Ohio

M. H. MAWHINNEY, Consulting Engineer, Salem, Ohio

E. T. MORTSON, Combustion Engineer, National Works, National Tube Company, McKeesport, Pennsylvania

W. H. DAILEY, JR., Chief Power and Fuel Engineer, Irvin Works, Carnegie-Illinois Steel Corporation, Dravosburg, Pennsylvania

E. E. CALLINAN: Mr. Mawhinney's paper is most timely in these days of demands for more and more production. He has emphasized the importance of the time factor on decarburization, stating that decarburization is proportional to the time of exposure to the furnace gases. Our experiences with decarburization of alloy steels indicate that time is a more important factor than furnace atmosphere. Consequently, in rolling mill furnaces proper attention must be given to the scheduling of heats, to the end that the steel will not be held up in the furnace because of a roll or size change. Also the orders preceding and following the steel on which decarburization is to be avoided should be such that the first and last billets will not be exposed to excessive temperature, for little or no decarburization occurs below 1425-50 F and if the steel can be brought pretty well down the furnace before this temperature is reached then the time at decarburizing temperatures is minimized. The use of plenty of kickout or dummy billets of the proper size ahead of and behind an order susceptible to decarburization pays dividends in quality, though perhaps not in fuel costs.

The control of furnace pressure on batch type furnaces is something we should expect to see more widely adopted. The ordinary batch furnace usually is designed so as to produce a positive pressure during heating, but during holding and cooling a negative pressure is generally encountered. Furnace pressure control at these stages would not only minimize the amount of O_2 entering the furnace, but also would permit better control of the cooling rate and the temperature uniformity during cooling. In some alloy steel plants the convection or recirculated air type furnace is being installed for batch type operations where temperatures do not exceed 1600 F. In this type furnace there is no chance for localized hot spots and the controllability and uniformity of cooling is enhanced, because, among other things a sufficient volume of gases is in circulation and positive pressure is maintained. Fuel consumption and time is said to be reduced materially by this type of furnace.

I was particularly interested in the furnace fired from the charging end — Figure 5, I believe. Can Mr. Mawhinney give us a little more information about this furnace?

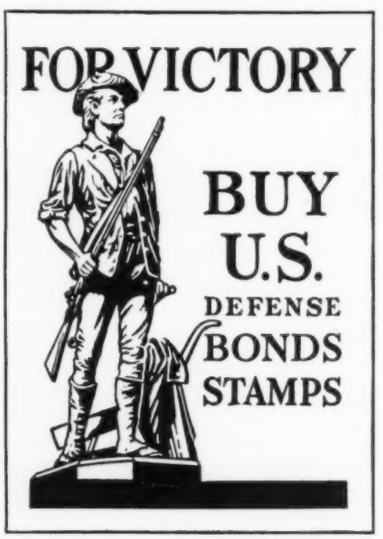
M. H. MAWHINNEY: The purpose is to be able to have a low heat on those slabs or billets which are about to be rolled next after the delay is over, without applying too much heat on the rest of the steel. In other words, the purpose is exactly as you have mentioned. The following billets must be kept as cool as possible and not held up at a high temperature. With the one-zone firing holding your end pieces ready to be rolled next, you overheat the ones behind. In order to overcome this, they have developed the small burners at the end with individual firing in the center zone.

E. T. MORTSON: I would like to ask Mr. Mawhinney what is the maximum furnace temperature that can be controlled and held in a rotary hearth furnace?

M. H. MAWHINNEY: That is tied up with the rate of heating, which is why we try to keep the heating rate down below 50 lb. If you exceed 50 lb, the furnace temperature becomes excessive. I would say that point is about 2400 F, which is about as high as you should go, because slag formation endangers the sand seals.

W. H. DAILEY, JR: I notice we are talking to some extent about the desirability of scheduling rolling operation so furnaces could heat uniformly. I would like to point out that it would be more desirable if we could build furnaces to suit the rolling mill schedule, for this reason: In general, the investment in our mills and in the power facilities is so much greater than furnace investment that we should endeavor in every way possible to make the furnaces fit mill operations, even when the rate of output varies over a wide range.

M. H. MAWHINNEY: That is perfectly true. There is a limit to it, however. It is accomplished by having more small furnaces in the tool steel mills where decarburization is most important; as many furnaces as possible and as small as practical. When you have reached the practical limit, then from there on you try to arrange your schedule so that you obtain heating rotation in as short cycles as possible. It is desirable to try to make the furnaces fit as well as possible. The continuous furnace is ideal. When you make tool steels which are susceptible to decarburization and yet involve small billets, small orders and all different temperatures, the continuous furnace is not applicable.



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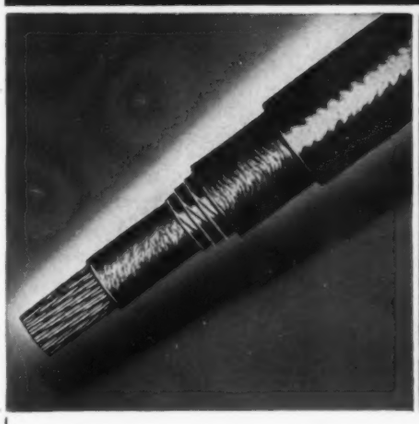

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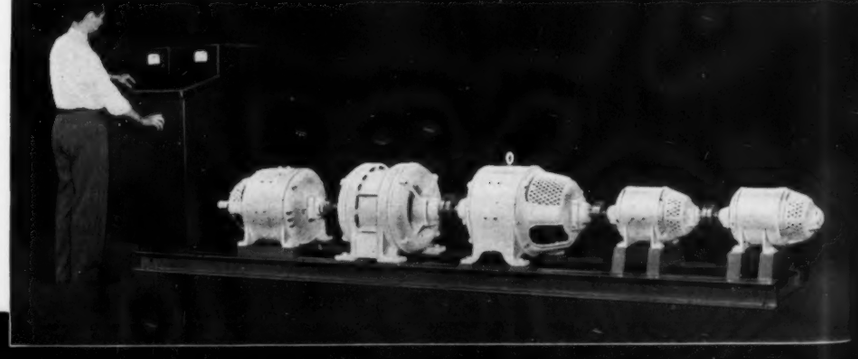

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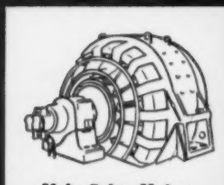

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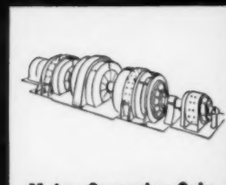

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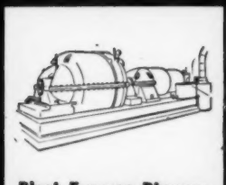

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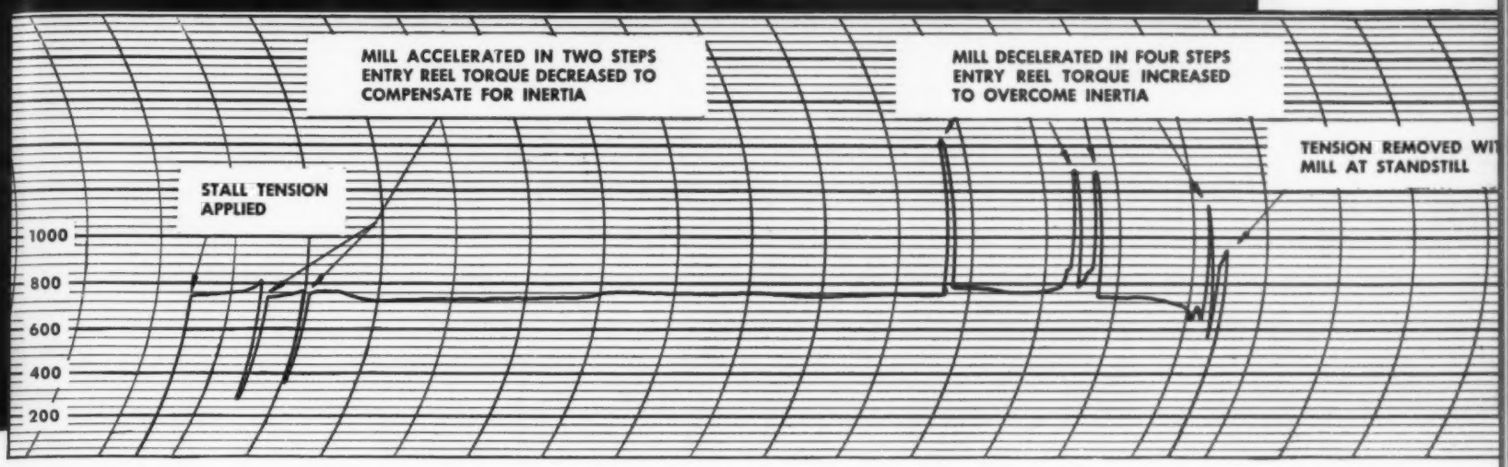
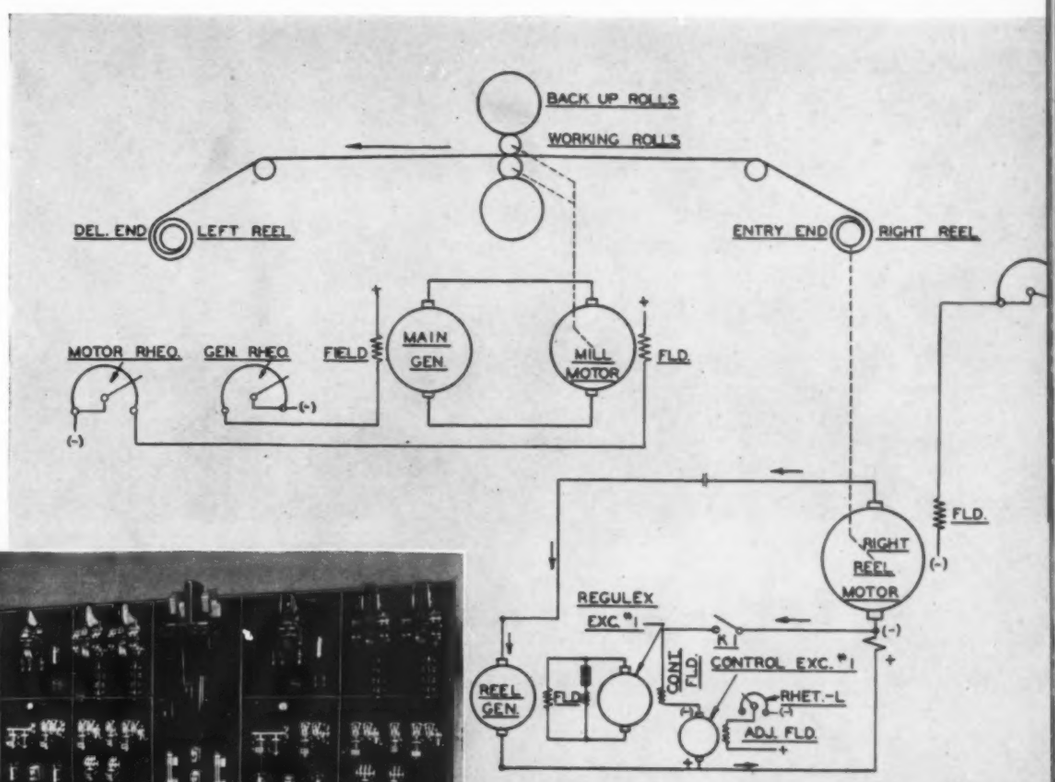
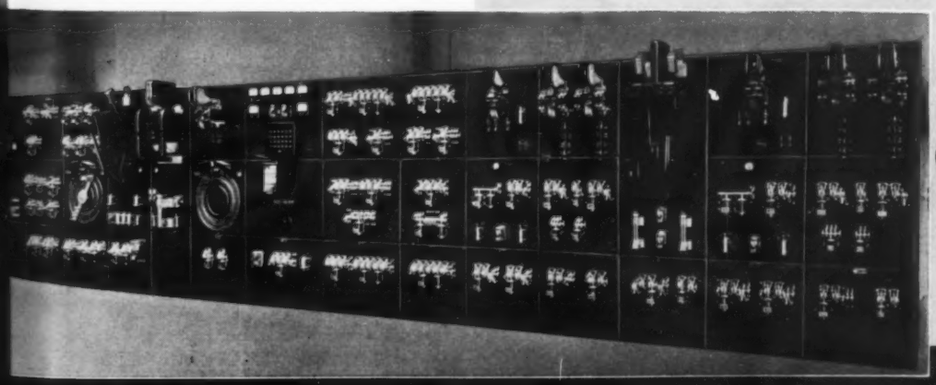


ABOVE: AMMETER CHART FOR ENTRY reel motor shows complete operating cycle — standstill-acceleration-normal running-deceleration-standstill. Note the almost instantaneous compensation made by the "Regulex" exciter for inertia during acceleration and deceleration.

AT RIGHT: SIMPLIFIED OPERATIONAL sketch of 34 in. single-stand cold reversing mill on which chart above was taken.

BELOW: CONTROL BOARD FOR 34 IN. REversing mill, where the "Regulex" exciter increases output... decreases strip breaking and wrinkling.





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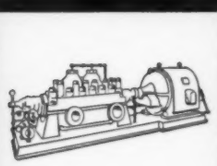
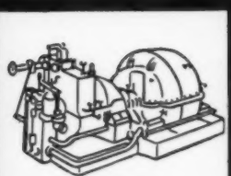
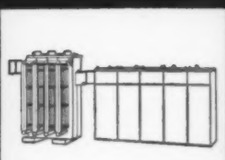

Descaling Pumps


Steam Turbines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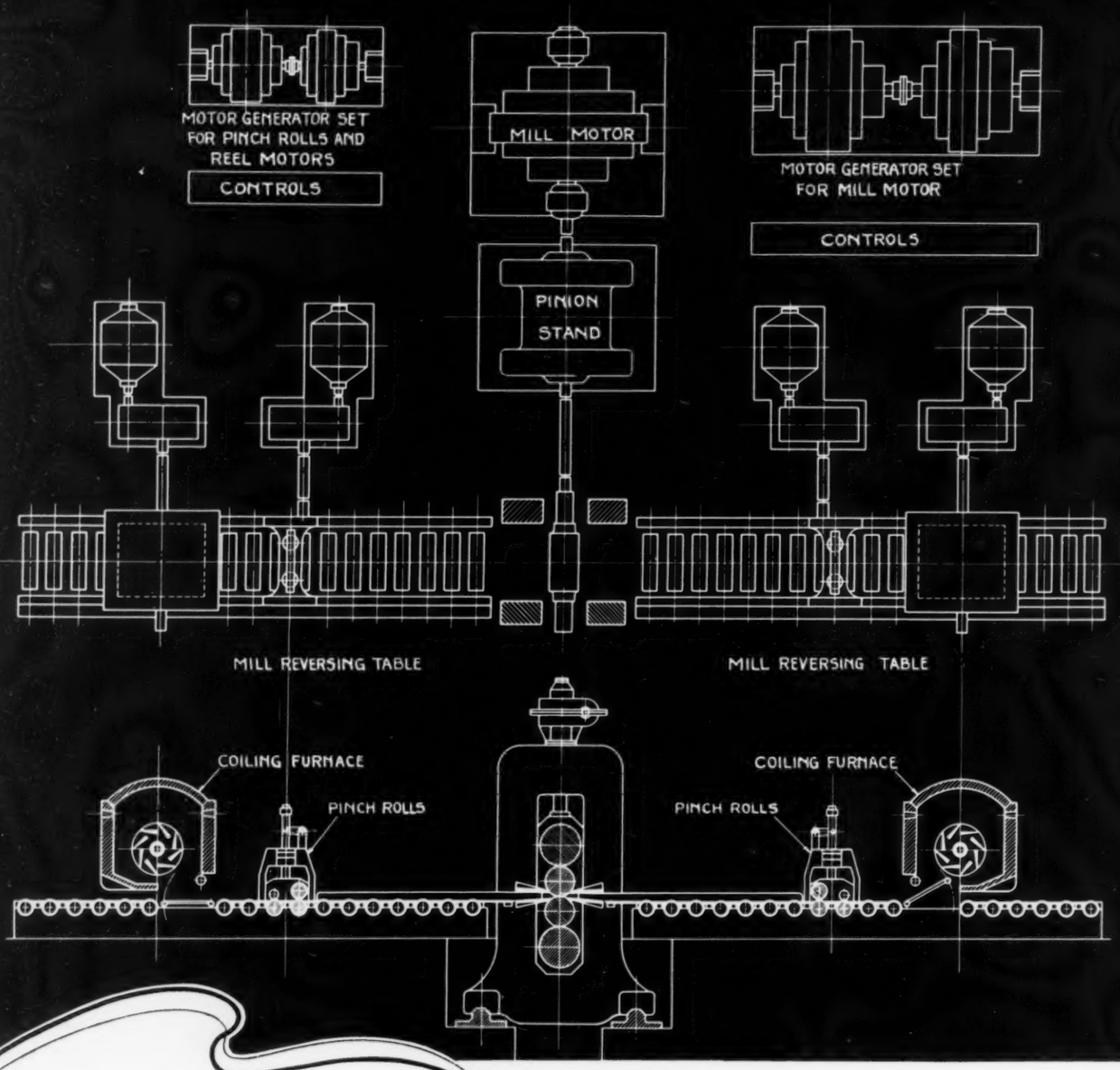

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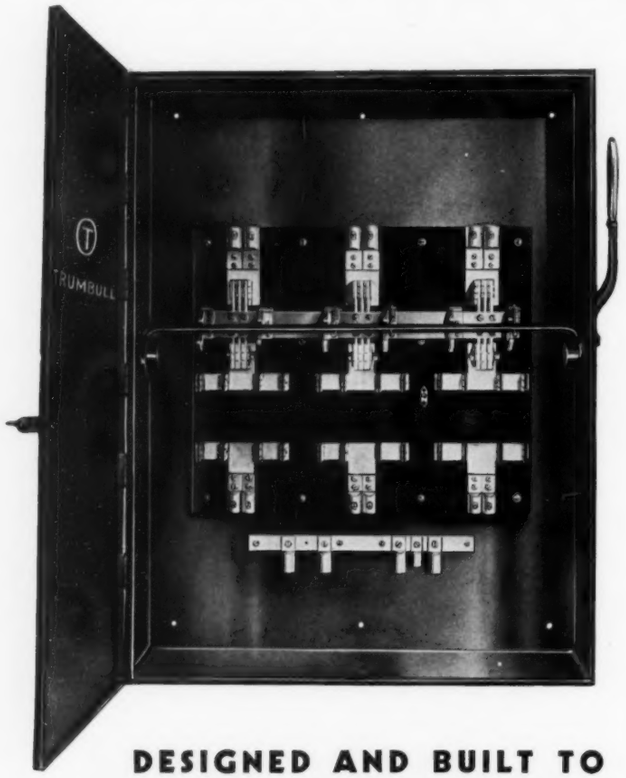

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THE TRUMBULL ELEC. MFG. CO. — PLAINVILLE CONN. U.S.A.

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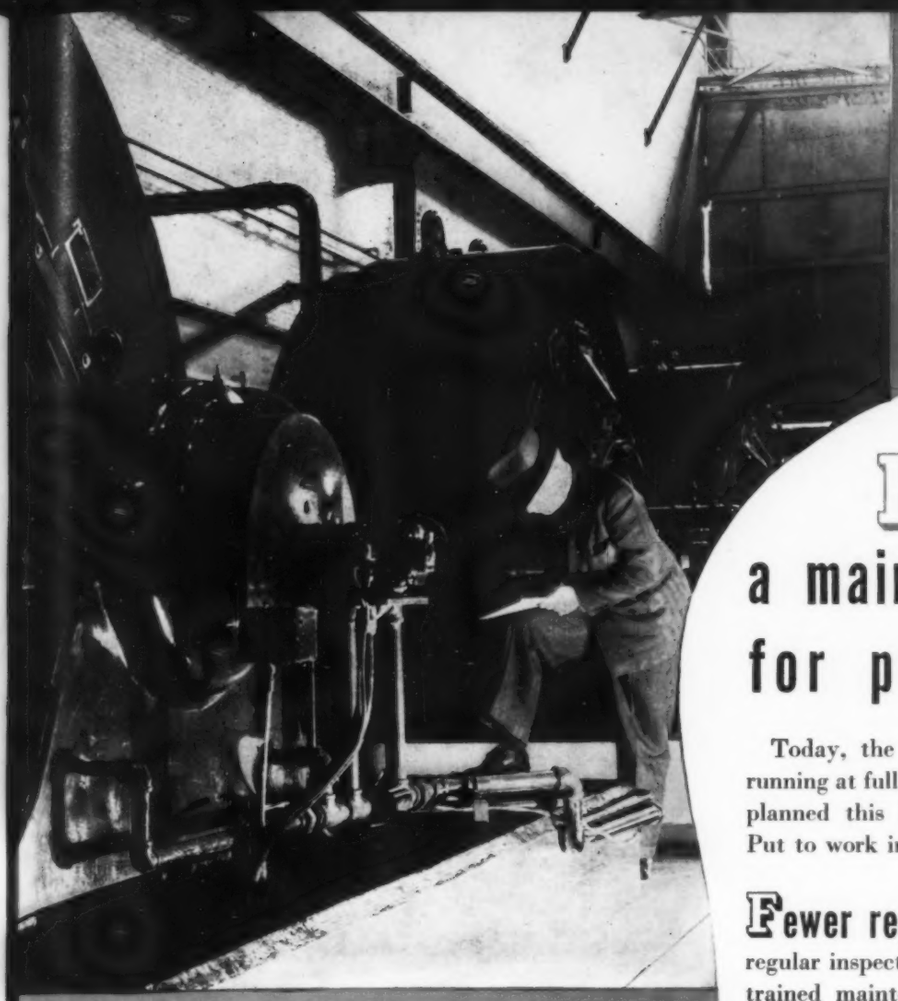


FSL...
a maintenance program for peak production

Today, the big job is to keep present equipment running at full capacity. To help you, Westinghouse has planned this F S L Wartime Maintenance Program. Put to work in your plant it means:

Fewer repairs—Fewer repairs will result from regular inspections, adequate maintenance records and trained maintenance men. Westinghouse is ready to supply you with helpful literature for this purpose.

Shorter repairs—Where repairs are made in your own plant, an adequate stock of renewal parts will shorten repair time. Recondition worn equipment promptly.

Westinghouse field engineers can help you diagnose trouble in your plant.

Longer-lasting repairs—For repairs made outside your own plant, use reliable repair service. Westinghouse facilities and experience will give you guaranteed results.

For complete details of this plan, turn the page.

Westinghouse

the FSL maintenance prog

One of the most important steps to better maintenance is proper training of new maintenance men. Plan your training program immediately.

There are many ways of keeping maintenance records. The important thing is to adopt one and be sure it is followed.

Fewer repairs

Insist upon regular inspections. By increasing the frequency of inspections, you can decrease major repair work. Minor repairs will be made before serious trouble can develop.

Keep adequate maintenance records. A maintenance record of every piece of equipment is essential to war production.

Train your maintenance men. Trained men mean better maintenance. A planned training program will improve your new maintenance personnel and keep production rolling. The educational literature illustrated on this page, supplied by Westinghouse, will help you educate maintenance men.

Regular inspections assure fewer repairs.

MAINTENANCE HINTS—A handbook of useful information about the care and repair of electrical equipment.

MAINTENANCE NEWS—A periodical that keeps maintenance men up to date on current methods.

CHECK CHART—Designed to keep your men reminded of the most frequently required maintenance operations on electrical equipment.

HUMAN INTEREST POSTERS—Machine operators should be cautioned to help keep equipment in good condition. To help you keep them reminded, Westinghouse offers, for posting on war bulletin boards, special "Bull-of-the-Woods" posters drawn by J. R. Williams, America's famous industrial cartoonist.

e program helps *Keep Equipment on the Job!*

Skilled craftsmen are available for major repair work to be done in your own plant.

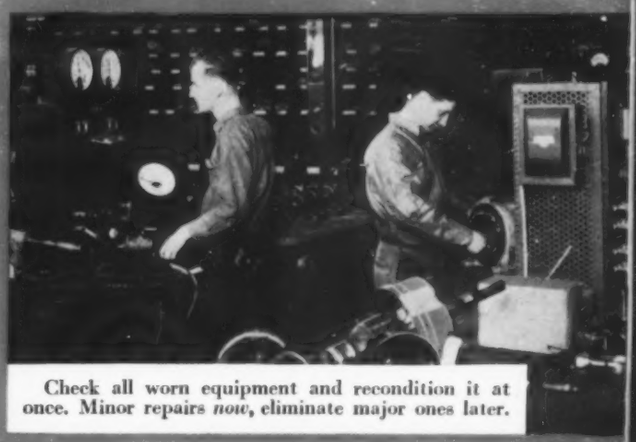
Shorter repairs

CHECK YOUR QUANTITIES OF RENEWAL PARTS—By keeping adequate supplies of regularly used renewal parts you will be prepared to make immediate replacements. To supplement your own repair parts stocks, our district warehouses carry, ready for immediate delivery—ample stocks of those parts most subjected to wear.

CHECK YOUR RANGE OF RENEWAL PARTS—By stocking renewal parts for *more* equipment, more of your machines can be put back into service quicker.

CHECK THE CONDITION OF SPARE EQUIPMENT—Whenever equipment is taken out of service because of failure, have it reconditioned at once, renewing all burned or worn parts, and hold it in stock for future use. Have a survey made in your plant *now* of all old equipment.

USE WESTINGHOUSE "FIELD ENGINEERING AND SERVICE"—Westinghouse engineers are available to help diagnose trouble and arrange for needed repairs in your plant. Portable field equipment assures accurate results.



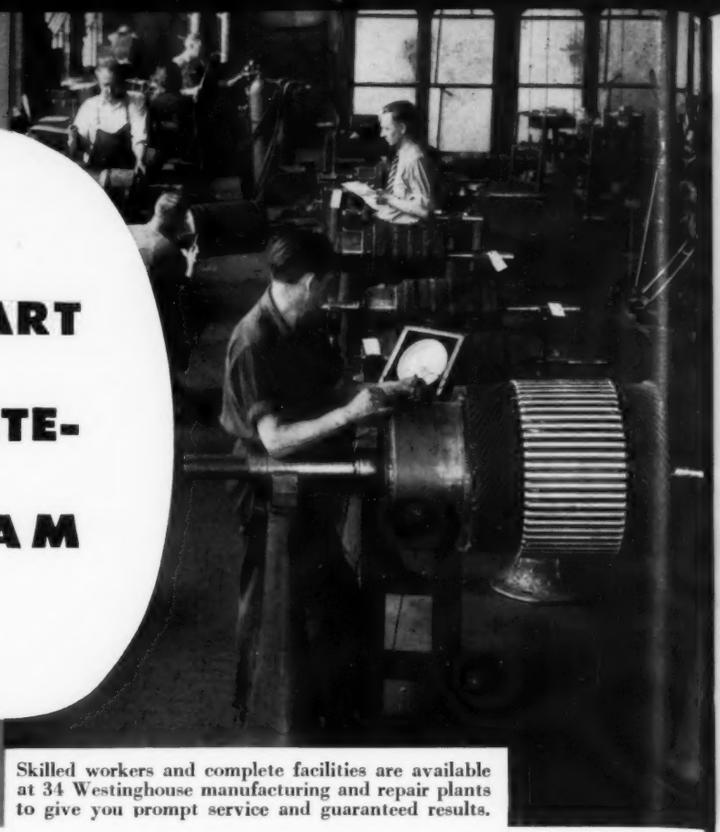
Check all worn equipment and recondition it at once. Minor repairs *now*, eliminate major ones later.

Stocks of renewal parts are at wartime capacity in each of 17 Westinghouse parts warehouses.

Westinghouse

AND FOR REPAIRS THAT LAST LONGER...

AN IMPORTANT PART OF THE FSL MAINTE-NANCE PROGRAM



Skilled workers and complete facilities are available at 34 Westinghouse manufacturing and repair plants to give you prompt service and guaranteed results.

Longer-lasting repairs

For repairs made outside of your plant, use the facilities of Westinghouse. You will gain these advantages:

Availability: There is a Westinghouse repair plant near you fully equipped to render fast dependable repair service when you need it.

Precision Equipment: Our repair plants are completely equipped with the most modern precision equipment for repair work. Equipment of this kind is seldom found in repair plants except those of the largest electrical manufacturers.

Proved Methods: The methods employed in all Westinghouse repair plants are the same as used in the manufacture of the original equipment.

Trained Men: All repairs are supervised by factory trained craftsmen with years of experience devoted exclusively to the manufacture and repair of steam and electrical equipment.

Accurate Testing: All repaired apparatus must measure up to rigid factory specifications. Results are assured by high frequency testing of coils, dynetric balancing, fatigue tests, etc.

Guaranteed Work: Because of these facilities and methods, Westinghouse can give you the same guarantee on repaired equipment that you get with all new Westinghouse equipment.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, EAST PITTSBURGH, PA.

Westinghouse Electric & Mfg. Company,
Maintenance Sales, Dept. 7-N,
East Pittsburgh, Pa.
Send sample copies of FSL Maintenance Program literature.

Name_____

Title_____

Company_____

Address_____

J-94493

The entire Westinghouse organization, including 17 parts warehouses and 34 repair plants, will help you put this F S L maintenance program to work in your plant. Fill in and mail the coupon NOW.

Westinghouse

UNCONSCIOUS waste in this land of plenty can become a serious handicap in our war effort. Let's take a case in point — oxygen. This element is vital to the speedy production of tanks, trucks, guns, ships, planes, and shells.

Oxygen consumption continues to skyrocket and the bottleneck remains steel cylinders. They just can't be obtained fast enough. But, we can all help by making every cylinder most useful. Here's how:

Make yourself a Waste Warden. See that the cylinders keep rolling. Don't let them get tied up in inventory. Be sure that cylinders are shipped back promptly when they are empty — and be sure to get the most gas out of each cylinder. If you see to it that these and other "do" and "don't" suggestions are followed you will be making a worthwhile contribution to our war effort as well as helping yourself.

Join the "Waste Wardens". Keep the cylinders rolling.

WASTE WARDEN SAYS:

DO close cylinder valve after use.
DO check your hose and connections for leaks.
DO keep inventory low.
DO return empty cylinders promptly.
DO keep tips clean and free from carbon and slag.

DON'T use excessive pressure.
DON'T use oversize tip.
DON'T leave tip burning when not in use.
DON'T abuse cylinders.
DON'T leave cylinder valves open when gas is not being used.

Air Reduction

60 EAST 42nd ST., NEW YORK, N. Y.

IN TEXAS: MAGNOLIA-AIRCO GAS PRODUCTS CO.

AIRCO WILSON

IDLE CYLINDERS ARE PRODUCTION SLACKERS: *Keep 'em rolling for victory!*

FIT...for the job ahead

In the battle of production, *as on the battlefield*, every Hyatt Roller Bearing is built to give a good account of itself.

Those who make, *and those who use*, the machines of war have welcomed Hyatt ability to stand up, unflinchingly, under high speeds, heavy loads and steady going.

Hyatt is proud of its part in the fight for Victory . . . glad to contribute its fifty years' experience in making better bearings . . . and will be in there serving "for the duration"... and thereafter!

Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

THIS IS THE 50TH YEAR OF HYATT ROLLER BEARINGS

T. C. I. EXPANSION PROGRESSES RAPIDLY

▲ A far-reaching program of expansion of steel making and finishing facilities of the Tennessee Coal, Iron and Railroad Company, a steel-producing subsidiary of the United States Steel Corporation, has reached virtual completion with the blowing in of a new blast furnace, which will increase the pig iron capacity of T.C.I. by 17 per cent.

The program, touching many important phases of company activities, was announced November 13, 1940. Wholly financed by U. S. Steel, the enlargement was occasioned by the then rising demand for steel products. Work was hastened by international developments, and as the program progressed it was directed, wherever possible, toward fulfillment of requirements arising from the government's war needs.

Already completed, according to Robert Gregg, president of the Tennessee company, are enlargements of production capacities at ore mines, coal mines and quarries, including installation of a considerable amount of new mechanical equipment, and construction of a battery of 73 by-product coke ovens.

Actual construction of the new blast furnace was started April 18, 1941. It features the most modern developments of blast furnace construction and is the first blast furnace in the territory with an all-welded outer shell.

Mr. Gregg called attention to the fact that work has started on another program announced last month which embraces construction of still another battery of 73 by-product coke ovens, opening of another coal mine and installation of electrolytic tinning facilities.

ORDER LIMITS PALM OIL USE

▲ To conserve the supply of palm oil, which is generally imported from overseas, the consumption of palm oil since April 1 has been limited to certain specified uses by general preference order M-59, issued by the director of industry operations.

Since April 1, the only permitted uses of palm oil has been as follows, unless other uses are specifically authorized by the director of industry operations:

1. The manufacture of tin plate, terne plate, long terne plate, steel sheets, steel strip and black plate.
2. Any manufacturing process in which glycerine is produced where the amount of glycerine remaining in the product does not exceed 1.5 per cent.

Processing of palm oil is also restricted to amounts necessary to meet normal production schedules of manufacturers who process for permitted uses.

Sale or delivery of palm oil has been restricted since April 1 to dealers or persons using the oil for permitted uses. This provision applies to intracompany transactions as well as to sales in the market. Users of palm oil throughout the United States have been notified by letter of the issuance of this order.

When you hear of the phenomenal speed in steel making for the war program, this ore bucket is one of the reasons. In one bite it grabs 25,000 lb of iron ore; two bites fill a freight car, and in seven it charges an 800 to 900 ton blast furnace. The bucket, believed to be the largest built to date, weighs 49,000 lb and is one of four being shipped by its maker, Blaw-Knox Company, Pittsburgh, Pennsylvania, for use in a midwestern steel mill.

D-C. BREAKERS AVAILABLE IN ENCLOSED UNITS

▲ General Electric's 250-volt d-c air circuit breaker switchgear equipments for heavy duty in steel mills, shipyards, and various industrial applications are now available in metal-enclosed cases, assuring complete safety to personnel and equipment by eliminating the possibility of inadvertent contact with live parts.

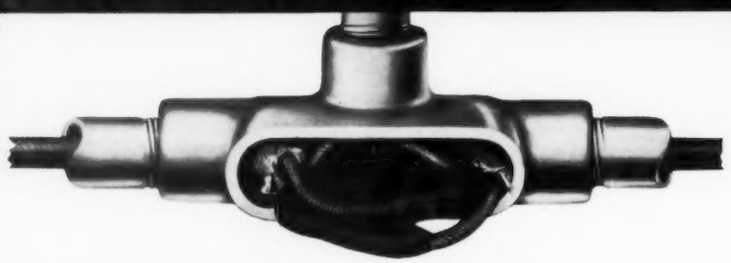
This latest development gives new safety features to the well-known MC-5 breaker, formerly available only in the "live-front" construction. Consequently, this breaker can be installed without the additional safeguards previously required in many locations.

The individual air circuit breakers, of the time-tested MC-5 type, are enclosed in separate steel compartments, as are the control devices of the contactor, thus giving a pleasing appearance with no unsightly live front devices visible. Control switches and instruments are mounted semi-flush on the steel panels of the doors to the control device compartments. Arc chutes specially designed to direct gases resulting from circuit interruption lead out from the top of the structure and away from the operating area.

Panels of the new equipment can be locked, making the interior accessible only to authorized persons for inspection.

Enclosing d-c breakers in steel cases gives new safety features and improved appearance.

Use **CONDULETS**, the easy-to-install conduit fittings, and **SAVE the TIME** of skilled electrical workers.



Obround **Condulets,** the general wiring series of the extensive **Condulet** line, have AMPLE WIRING SPACE and UNOBSTRUCTED COVER OPENINGS that—

- Make it easy to pull conductors.
- Make splicing and taping easy.
- Remove the possibility of injury to conductors during installation.

SAVE TIME

A Nationwide Distribution Through Electrical Wholesalers

CONDULETS—The Standard of Quality in the field of electrical conduit fittings.

CROUSE-HINDS COMPANY
SYRACUSE, N. Y., U. S. A.

Sales Offices: Birmingham — Boston — Chicago — Cincinnati — Cleveland — Dallas — Detroit — Houston — Kansas City — Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington

Resident Salesmen: Albany — Atlanta — Baltimore — Buffalo — Charlotte — Denver — Louisville — New Orleans

CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

ANNOUNCES CONSTANT LEVEL LUBRICATOR

▲ Of timely importance for the protection of today's vital machinery is this new Oil-Rite constant level lubricator. It holds a visible reserve supply of oil — releases automatically just as much as is needed to maintain a constant predetermined level of lubricant. Its use is said to (1) insure adequate lubrication at all times and (2) prevent oil waste, and the deterioration or spoilage of material caused by oil throw.

This new level lubricator is used on electric motors, pillow blocks, textile and paper making machinery, pumps, air conditioning equipment, ventilating fans, gear boxes — wherever bearings and other machinery parts must

be provided with an ample supply of lubrication.

Construction of the Oil-Rite lubricator consists of only three simple parts. The base is cast of Zamak metal, with an integral open air vent which extends part way up into the oil reservoir. Over this vent is fitted loosely an inverted bucket, or bell, also cast of Zamak metal. The reservoir proper is a glass dome, sealed to a metal collar by plastic porcelain cement which is impervious to acids, oils, water and heat. Two spring clips lock the oil reservoir in position. A felt gasket around the outside of the bell seats against the narrower neck of the glass dome when the reservoir is removed — prevents waste of oil during refilling.

Oil-Rite constant level lubricators are available in four standard sizes, with capacities of 2, 4, 8, and 16 oz. Outlet tappings are provided at both side and bottom of base, and oil level to be maintained is clearly indicated. Air vent can be provided with filter if desired, or can be installed with breather tube connecting to bearing. Complete details for all applications will be furnished by the manufacturer, Oil-Rite Corporation, 3466 S. 13th Street, Milwaukee, Wisconsin.

FURNACE CONTRACT FOR SOUTH AMERICA

▲ Contracts for soaking pits and reheating furnaces for the first complete steel mill in South America have been awarded to the Rust Furnace Company, Pittsburgh, Pennsylvania.

The contracts include design and supervision of construction with native labor. The mill will be located in the State of Rio de Janeiro, Brazil.

The mill will provide South America with its first facilities for producing rails, plates, and structural steel shapes, all of which heretofore have been imported, chiefly from Germany because of price.

South American steel facilities are at present limited to a few rod mills for making reinforcing rods. This means that in the construction of the new mill almost every item installed, even down to nuts and bolts, must be imported.

Prime contracting engineer for the Brazilian mill, undertaken for the newly formed National Steel Company of Brazil, is Arthur G. McKee Company of Cleveland, Ohio.

MANUFACTURER ADDS BUILDING FACILITIES

▲ The Farrel-Birmingham Company of Ansonia, Conn., has awarded the general contract for the construction of its new plant in Northern New York to the Turner Construction Company, it was announced by President Nelson W. Pickering.

Plans by Thomas H. McKaig, architect and structural engineer, provide for a one-story structural steel, brick and glass manufacturing building measuring 603 ft x 203 ft, with three craneways, together with an office building, powerhouse and cafeteria. Beman and Candee are mechanical engineers. Estimated cost has been placed at $4,000,000.

Complete Control from One Position Contributes to

High Output of Rolls from FARREL ROLL GRINDERS

This illustration of the control panel of the Farrel Heavy Duty Roll Grinder shows at a glance how *centralized fingertip control* contributes to the high output of accurately ground and flawlessly finished rolls for which this machine is noted.

Without moving from his station, the operator may reach any control button or rheostat with a single movement of the arm. On a fully enclosed panel at the operator's right are located all push buttons and rheostats for the control of the several motors, with the exception of the rapid wheel feed, which is located on the operator's left next to the indexed handwheel for hand feeding of the grinding wheel. For ease in setting up a roll in the grinder, additional push buttons for controlling the headstock motor are mounted on the headstock.

This complete *centralized fingertip control* reduces movement of the operator to a minimum; his entire attention and energy may be devoted to the work, thus assuring a continuity of output and a high daily *production with precision* which keeps roll refinishing costs at a minimum.

For full particulars of additional features which combine to give the Farrel Heavy Duty Roll Grinder its record for smooth, vibrationless performance, superior finish and high output, let us send you a copy of Bulletin No. 111. This booklet contains complete specifications and illustrated description of all features.

FARREL FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

ANNOUNCES "CONTROL CENTER" SWITCHBOARD

▲ The Trumbull Electric Manufacturing Company of Plainville, Connecticut, recently announced a new line of "control center" switchboards, of a construction similar to their motor control centers — consisting of

Control center switchboards provide flexible arrangements and easy installation.

any assorted assembly of switch or circuit breaker units, 30 to 200 ampere capacity, in vertical section troughs, in which power is supplied through the busbar.

These assemblies may be installed in one central point and immediate connection made with the load by simply inserting the switch or circuit breaker units (switches equipped with stabs) under the busbars in the power troughs.

These assemblies provide great flexibility and convertibility, and all interior parts are completely accessible from the front.

PROCESS SPEEDS BOMB PRODUCTION

▲ B. F. Harris, president of the National Tube Company, a United States Steel Corporation subsidiary, announced that bomb production by a new "spinning" method described as revolutionary in character developed and perfected at one of the company's plants, has reached the point of efficiency where the process can be utilized at other plants for turning out increasing quantities of this vital American war weapon.

As a result, production of bombs by

Lost hours are lost production!

FOR MORE PRODUCTION WITHOUT MORE MAN HOURS

SAVE maintenance hours—STRETCH bearing surface life—with extra protective film built up by DIXON'S TICONDEROGA Flake Lubricating Graphite. There's a need NOW, more than ever, for this enduring lubricant.

Use alone or in greases to supplement or supplant ordinary lubrication where extremes of temperature, pressure, speed, moisture make ordinary lubrication insufficient.

DIXON'S FLAKE GRAPHITE

Available in two particle sizes: No. 1—large, unctuous, lustrous flakes; No. 2 — finely powdered flakes. For close-fitting bearings, Dixon's No. 635—minutely subdivided, powdered flakes smaller than No. 2. DIXON'S ROLL NECK LUBRICANTS FOR ALL PLAIN OPEN BEARINGS SAVE ROLLS, BRASSES, LUBRICANT AND LUBRICATION COST.

GRAPHITE EXCELLENCE SINCE 1827

JOSEPH DIXON CRUCIBLE COMPANY, JERSEY CITY, N. J.

Ticonderoga Graphite • No. 635 Graphite • Microfyne Graphite • Pipe Joint Compound • Graphite Seal • Graphited Oils • Cup and Pressure Gun Grease • Gear Lubricants • Waterproof Graphited Grease • Auto-Marine Grease • Graph-Air Guns • Belt Dressing (Contains no Graphite).

this method for the Army and Navy will be greatly increased. The process is being utilized by the Army Ordnance Department which will have installed similar machines in plants of other manufacturers, and the National Tube Company is lending its aid in educating these potential producers by giving them the benefit of experience gained from nearly twenty months of actual production.

Bomb production by the "spinning" method developed by the company is speedy and effective. The process is one in which many government officials as well as commercial operators now converting their plants to war production have shown great interest.

In developing the new process, heavy industry has taken a leaf from the book of the ancients, and utilizes, with great modern machines, the methods of the potter and his wheel. A pre-heated steel tube, turned at a high rate of speed, is fashioned quickly and with surprising precision, into the nose and main body of a bomb by a huge arm which swings into position and molds the revolving tube into the desired shape. Other machines, by the same method, shape the tail portion of the main bomb body with the ease of an old time potter forming his whirling clay.

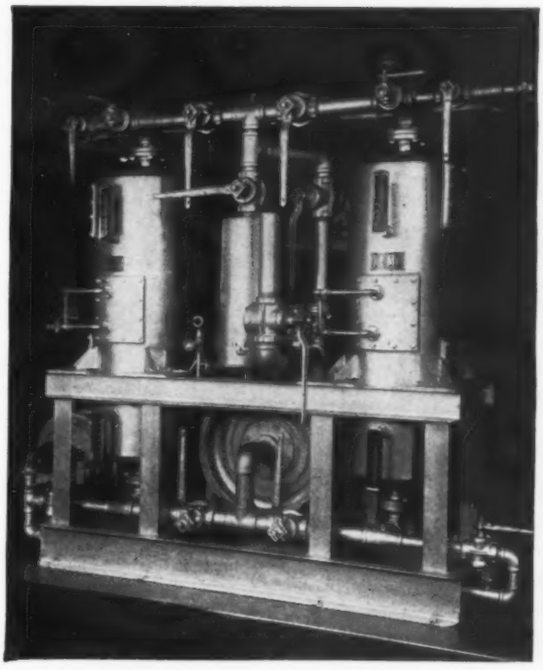
Bombs of various sizes are made by this method, and after they leave the spinning machines they are normalized, finished, threaded, have carrying lugs welded on, are painted and shipped to loading plants as the first leg on their journey toward action.

About the same time that British soldiers were evacuating Dunkirk, bomb production on a large scale began at this plant after months of research, experimentation, and limited production. In an amazingly short time, men had to be trained to operate these great machines and to work effectively in the important finishing lines. Maximum output from the spinners through to shipment had to be attained and maintained. A tremendous training job had to be accomplished. The result is that today, with an average age of twenty-three, the men of "Bomb Bay" are a smooth-running team, contributing to their country's gigantic war effort — producing for Victory.

STEEL PLANTS TO BE EXPANDED

▲ Columbia Steel Company, subsidiary of United States Steel Corporation, announced additions and improvements to its Pittsburgh and Torrance, California, plants which will increase materially their production of steel for the nation's war effort. The expansion program, which will provide additional open hearth and electric furnace capacity as well as alterations and improvements in finishing facilities, will be undertaken entirely with the corporation's own funds at an estimated cost of $8,500,000. The installation will be completed with all possible speed.

The additional expansion of Columbia's steel-making facilities will complete U. S. Steel's part, amounting to more than one-third, in the 10,000,000-ton steel ingot expansion



for

DRY

ANNEALING ATMOSPHERES

KEMP SILICA GEL DEHYDRATORS

guarantee the *exact* degree of dryness you need in *your* annealing atmospheres.

Designed by gas equipment engineers; and proven by an impressive record of dependable and economical operation in plants demanding constant and exact drying of annealing atmospheres.

Write **The C. M. Kemp Mfg. Company, 405 East Oliver Street, Baltimore, Maryland—ask for Dryer Bulletin.**

STANDARD UNITS BUILT TO GIVE:
Capacities: 10 to 100,000 c.f.m.
Pressures: Atmospheric to 2500 lbs. per square inch
Adsorbent: Silica Gel, high capacity, long life
Activation: By gas, electricity, or steam, as desired
Types: Single or twin towers for intermittent or continuous operation

KEMP of BALTIMORE

program recommended last year by Government defense authorities.

These new U. S. Steel facilities, the major part of which are being built at the expense and for account of the Government, embrace, in addition to the Columbia Steel program, vast new iron and steel producing facilities in the Pittsburgh, Pennsylvania, and Chicago, Illinois, Districts, and the construction of new iron and steel producing and finishing facilities in Utah and California. In addition, United States Steel Corporation has numerous other projects providing substantial additions and improvements to its manufacturing facilities in various localities to meet war-time demands. Work on these various projects is rapidly going forward.

MILLING CUTTER SPEEDS PRODUCTION

▲ At a time when manufacturers of standard milling cutters are unable to keep up with the demand, McKenna Metals Company, 145 Lloyd Avenue, Latrobe, Pennsylvania, announces a method by which simple facing cutter heads may be made in almost any shop. Due to its high speed of cutting, this single-bladed "Kannamill," employing Kennametal tools, will often work more efficiently than a standard cutter requiring many high speed steel blades.

Designed with a large negative spiral angle of 35 to 55 degrees and positive hook of 15 to 25 degrees, this cutter mills steel efficiently only because Kennametal does not "gall" or permit the adherance of steel chips to the hard, strong, non-galling tool tip which "skids" the steel chip off smoothly at these angles.

For roughing, with cuts up to 3/8 in. deep, a 35 degree negative helical angle and 15 degree positive hook on a 12 in. diameter cutter head has been found to work efficiently. For light finishing cuts a negative helix of 55 degrees with 20 degree positive hook angle is most efficient. The hook angle should be less on a smaller diameter head.

Kennametal cutters should be run to give 300 to 600 fpm peripheral speed, with a table feed of .008 in. per revolution, depending on the material being machined. A 6 in. diameter head gives about 3 in. per min. table feed at 380 rpm (600 fpm cutting speed). Clearances should be kept to a minimum and only a slight radius used. No coolant should be used as it is impossible to keep the cutting point flooded at the speeds employed.

The Kennametal-tipped blades can be removed from the cutter heads and reground quickly, an important advantage over standard cutters, which require removal of the entire head from the machine, with consequent loss of time.

The manufacturer will be pleased to furnish additional information upon request.

BLOOM ENGINEERING
CAN HELP YOU
CONSERVE FUEL
through 1. CORRECTLY ENGINEERED APPLICATIONS

Good application engineering is the basis for worthwhile fuel savings. Bloom experience guarantees correctly engineered jobs.

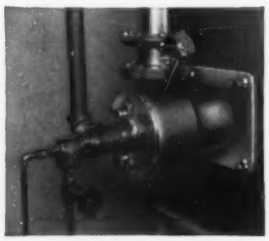
2. MODERN EFFICIENT BURNERS

The modern design of Bloom Long Flame Burners provides most efficient combustion and uniform heating.

3. QUICK CHANGE-OVER

Protect your production against fuel shortages by installing Bloom Combination Burners, and switch from gas to oil—or from oil to gas INSTANTLY! No delay, no shutdowns, same heating results.

WRITE *for information, giving full data on your present equipment and work handled.*



Bloom Long Flame Combination Burner.

BLOOM ENGINEERING COMPANY
916 BEHAN STREET PITTSBURGH, PA.

Available Literature

▲ For low voltage starting of non-reversing, squirrel-cage, 2- and 3-phase, 5 to 200-hp induction motors, manual auto-starters are described in a new four-page leaflet announced by Westinghouse Electric and Manufacturing Company.

Two-step operation with protection against low voltage overload and incorrect sequence is discussed. Interlocked starting sequence and automatic return to "off" position are described with a note on rolling contacts and bimetal relays. Gasketed

enclosures, methods of arc extinction, and accessories are included.

The leaflet is well-illustrated with wiring diagrams and closeup views of principle parts. A tabulation lists recommended starter sizes for common horsepower and voltage ratings of motors used on 25, 40, 50 and 60-cycle circuits.

A copy of descriptive data 10-700 may be secured from department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

▲ Peabody Engineering Corporation, 580 Fifth Avenue, New York City announces the availability of three new engineering bulletins. One bulletin describes their Type-A and Type-H Oil Burners. The second bulletin describes this company's gas and oil burners, while the third bulletin contains a description of their C-D wide range oil burner system.

▲ We Work for Victory and We Plan for Peace, a dramatically illustrated brochure designed to show what products Allis-Chalmers is making under war-time conditions and where and how these products are helping to produce more guns, tanks, planes and ships, is now being distributed by this company.

Nearly every phase of the nation's industrial production is represented in the new book, since Allis-Chalmers produces a greater variety of capital goods than any other company in the world. These products, now vital in war production are, for the most part, the same Allis-Chalmers has always made.

They include power-making equipment, such as hydraulic and steam turbines; power-distributing equipment, like transformers, rectifiers, switchgear and regulators; and power-using machines, such as motors, drives and pumps. In addition, the company's products are essential in mining and processing of metals of all kinds, in cement making, road building, farming, food processing, the oil industry and scores of other industries whose production is the basis of America's war production.

Scores of war items new to Allis-Chalmers production complete this company's contribution to the war effort, as colorfully described and illustrated in the new Allis-Chalmers victory book.

The book is being distributed in conjunction with the showing of a sound moving picture with the same title and the same general theme. In news-reel style the movie brings to life many of the views shown in the book.

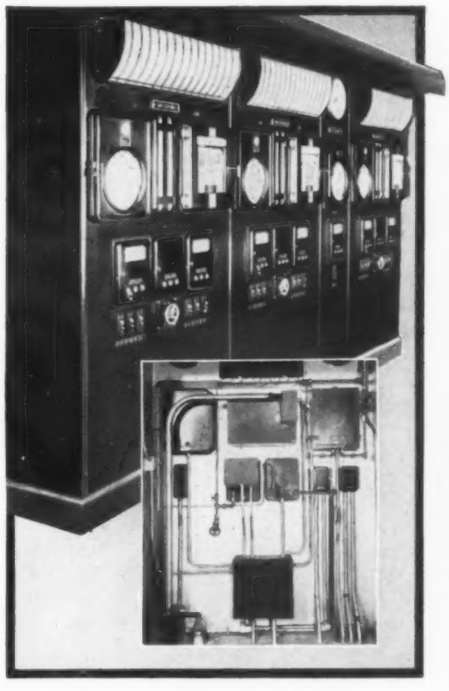
▲ A new bulletin has just been issued, presenting the complete line of Foxboro potentiometer temperature indicators and indicating resistance thermometers. The instruments illustrated and described include single-point and multiple-point models, models equipped with selective key-switches for as many as 82 contact points, as well as the popular portable models. Single range and double range dials are shown in full-size reproductions and a complete list of standard ranges is given. Constructional features of the instruments are shown and described, many of these features being exclusive in Foxboro design.

Copies of the Bulletin, No. A-305, will be sent on request. Address the Foxboro Company, Foxboro, Mass.

▲ As an aid to power engineers who are faced with the necessity of meeting sharply increased steam demands and who will be obliged to operate their boiler plants on a 168-hr week schedule, Bailey Meter Company has prepared a 20-page bulletin, No. 16, entitled "How to Safely Stretch Steaming Capacity."

Numerous fundamental suggestions are made under the general headings of:

1. Check condition of boiler and furnace.
2. Check operating procedure.
3. Check possibilities for modernization.
4. Base daily operation on accurate measurements and records.



Electric
ALL THE WAY!

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AUTOMATIC
COMBUSTION
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Stokers, pulverizers, fans and oil burners are more and more becoming electrically driven. It is entirely logical therefore that an automatic combustion control system be operated electrically. Hays *centralized* control is operated entirely by electricity, employing enclosed mercury switches for the sensitive contacts, thus assuring freedom from trouble due to moisture, dust, dirt and chattering. Electric operation also simplifies installation and maintenance. Adjustments are made direct and are not dependent upon air pressures, oil pressures, and the numerous valve mechanisms made necessary by non-electric designs. When considering automatic combustion control buy for tomorrow—buy electric—buy HAYS.

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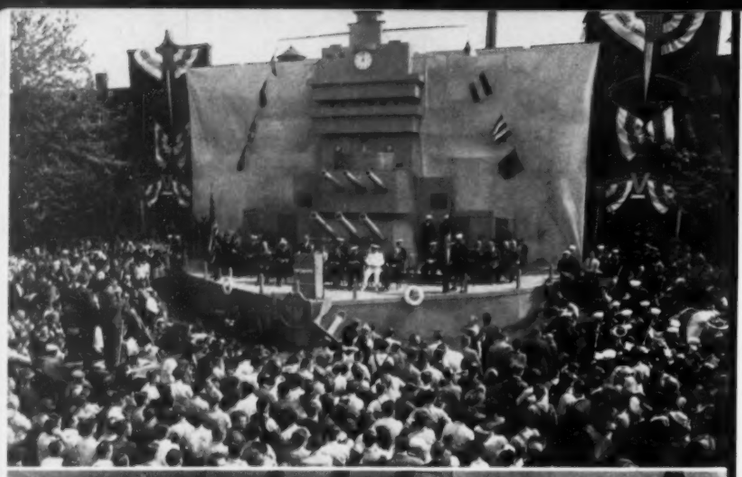
THE MODERN SYSTEM—*it's Electric!*
THE HAYS CORPORATION • • • MICHIGAN CITY, INDIANA



THREE MORE FIRMS AWARDED NAVY "E"

Significant of the fine work being performed by United States industry are the continued awards of the Navy "E" for production achievement. Particularly impressive was the presentation ceremony to the Automatic Transportation Company at Chicago, Illinois, where a replica of a battleship was erected to serve as a speaker's platform (upper left). Lieutenant Governor Hugh Cross, of the State of Illinois, delivered the address of welcome, and paid high tribute to the employes and management of the company. After the public ceremonies were concluded, a plant inspection tour was made by Navy and government officials, under the guidance of E. F. Twyman, general manager of the Automatic Transportation Company.

At Milwaukee, Wisconsin, the Harnischfeger Corporation was recently awarded the Navy "E." A current "Beat the Schedule" campaign has resulted in important gains in production of the plant. At lower left, Rear Admiral Cluverius, USN, is shown congratulating Walter Harnischfeger, president of the company.

Another presentation, in Cleveland, Ohio, brought the Navy "E" pennant to the Reliance Electric and Engineering Company. The 1300 employes of the company also received gold emblems bearing as a design a ship, the navy anchor and eagle and the "E" with the legend "For Production." The photograph below shows the color guard hoisting the pennant following the presentation ceremony.

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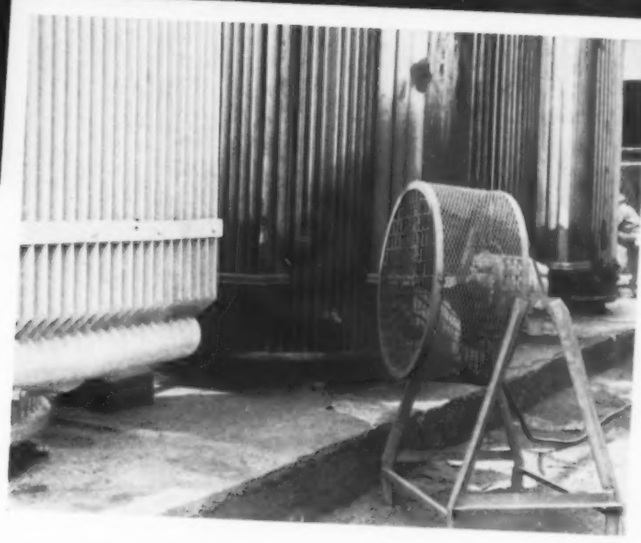
Help keep your workmen on their toes

Portable Fan No. TF-100, recognized as standard in many of the country's largest mills. Sizes from 12 in. to 36 in. in diameter.



Portable Fan No. TF-300 in operation, cooling large transformers in strip mill.

Crane Cab Fan, for cooling crane cab interiors and other confined areas. Available in 12 in. and 18 in. sizes, adjustable both horizontally and vertically.

Portable Fan No. TF-300W. Angle iron support adjusts for vertical or horizontal discharge through almost 360°.

It's more important now than ever before to keep your workmen comfortable. For comfortable workmen are more efficient, produce more work in a given time.

Truflo Fans can help you keep your workmen on their toes. All Truflo Fans are designed and built correctly for efficient, economical operation — they move more air per dollar. Write for free literature on any of the following styles:

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TRUFLO FAN COMPANY

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ITEMS OF INTEREST

R. S. Poister was recently appointed manager in the Chicago District of the Youngstown Sheet and Tube Company. Mr. Poister attended Carnegie Institute of Technology, Pittsburgh, and Case School of Applied Science, Cleveland. Upon completing his education, he started in the steel business with the Cleveland Furnace Company, Cleveland. Soon after he went to the old United Steel Company, which is now the Canton Plant of the Republic Steel Corporation.

Mr. Poister went with the Youngstown Sheet and Tube Company, Indiana Harbor Works, as assistant general superintendent in the spring of 1936 from the Alan Wood Steel Company, Conshohocken, Pennsylvania, and was promoted to general superintendent in charge of steel and coke plants in 1937. His practical and technical knowledge and efficient administration won for him the position he assumes today.

George W. Abel was appointed assistant general superintendent of the Indiana Harbor Works steel plant recently. Mr. Abel attended Armour Academy High School of Chicago and was graduated from the University of Illinois. Soon after completing his academic education, he started his steel mill career with the Illinois Steel Company, South Works, Chicago, which is now Carnegie-Illinois Steel Corporation. He advanced from line positions and became a superintendent in 1920.

Mr. Abel went to the Youngstown Sheet and Tube Company, Indiana Harbor Works, as superintendent of rolling mill department in 1929.

R. S. POISTER

Kenneth A. Staats, formerly district representative for the Pyle-National Company, Chicago, Illinois, has joined the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Prior to joining Pyle-National in 1937, Mr. Staats was instrument supervisor of Jones and Laughlin's Aliquippa Works and his present position will be along the same general lines.

L. S. Hamaker has been appointed as assistant general manager of sales of Republic Steel Corporation. Mr. Hamaker will transfer his headquarters to Cleveland immediately from the Berger Manufacturing Division of Republic at Canton, Ohio, where he has been general manager since 1934.

Born and raised in Canton, Mr. Hamaker attended public school and high school there. His first contact with the steel industry was as the operator of a billet pusher on a bar mill heating furnace in one of the Canton mills now part of Republic.

During World War I, Mr. Hamaker served in the United States Marine Corps, returning to Canton in May 1919 to join the sales department of the Berger Manufacturing Company, later transferring to the company's advertising department.

In 1925, Mr. Hamaker became advertising manager of United Alloy Steel Corporation, Canton, with which the Berger Manufacturing Company had been merged shortly before. Subsequently, he became advertising manager of Central Alloy Steel Corporation, Massillon, Ohio, when United Alloy was merged with it. Republic Steel Corporation acquired Central Alloy Steel in 1930, and in 1931 transferred Mr. Hamaker to Youngstown as sales promotion and advertising manager.

When the Berger organization was set up as a division of Republic Steel Corporation in 1934, Mr. Hamaker was made general manager and has served in that capacity since. His new duties will involve both the sales of Republic fabricating divisions and the general line of steel products.

Wallace K. Brown has been appointed vice president in charge of procurement, Crocker-Wheeler Electric Manufacturing Company, Ampere, New Jersey. Associated with the company since 1908, he has since served as district manager in San Francisco and Newark, New Jersey, eastern sales manager in New York, and vice president and general sales manager.

Norman E. Thompson has been appointed assistant general superintendent, Birmingham, Alabama, division, southern district, Republic Steel Corporation. **John L. Adcock** has been named superintendent of blast furnaces and coke plants in the same district. Mr. Thompson, who joined the steel industry in 1919 when he went to work for the old Republic Iron and Steel

Company as assistant engineer at the Rainund ore mines, recently has been district superintendent of ore mines of the company. Mr. Adcock joined Republic at Warren, Ohio, in 1930, leaving to go to Russia as a foreman with Freyn Engineering Company. He returned to the company in 1933 and left again in 1934 to go to England as a blast furnace superintendent with H. A. Brassert and Company. Since 1937 he has been foreman of the Gulf steel blast furnace of Republic Steel.

NEWBOLD C. GOIN

Newbold C. Goin, sales manager of the Gearing Division, Nuttal Works, Westinghouse Electric and Manufacturing Company, has resigned this position to accept the secretary-managership of the American Gear Association. Mr. Goin was born in Lemont, Illinois in 1895, and had been associated with Westinghouse Electric and Manufacturing Company since 1917. He had been employed as a field service engineer in the southeastern and central districts, and also had been a salesman in the central district. Mr. Goin has been a member of the Association of Iron and Steel Engineers since 1925. Mr. Goin succeeds Mr. J. C. McQuiston. This change was effective May 1st.

Howard W. Broecker has been appointed assistant district manager, Chicago district, Copperweld Steel Company, Warren, Ohio. Mr. Broecker previously was connected with Youngstown Sheet and Tube Company and the Interstate Iron and Steel Company in the Chicago district.

WANTED — Mechanical and Electrical Engineers on steel plant construction. Location, Cleveland. Salary. Give full particulars and salary in first letter. Apply Construction Engineer, American Steel and Wire Company, Rockefeller Building, Cleveland, Ohio.

Francis J. Burtt has been appointed director of industrial relations of the American Steel and Wire Company, subsidiary of the United States Steel Corporation. He succeeds **E. W. Kempton,** who has been transferred to the United States Steel Corporation of Delaware.

Born in Pittsburgh, Pennsylvania, Mr. Burtt was educated in the public schools there and at Bellevue, Pennsylvania, before he matriculated at the University of Pittsburgh, from which he was graduated with a B.S. Degree in mechanical engineering. He worked for the Mackintosh-Hemphill Company, the Duquesne Light Company, and the Pressed Steel Car Company before becoming associated with the American Steel and Wire Company in September, 1927, as a draftsman at the Donora, Pennsylvania, wire works. In June, 1933, Mr. Burtt was made assistant to the master mechanic at the same plant. In January, 1937, he was made foreman in the electric welding and field fence department, and in May of the following year he was appointed superintendent of wire and wire products at the Donora Steel and Wire Works. In February, 1941, Mr. Burtt was transferred to Cleveland as assistant director of industrial relations, which post he has held to the present time.

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IRON & STEEL ENGINEERS

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1

The A.I.S.E. Spring Conference, held at Hamilton, Ontario, on Monday and Tuesday, May 11 and 12, was attended by more than 350 members and guests of the Association. Of this number, 250 were visitors from the United States, all of whom enjoyed the fine hospitality extended by the Canadian members and their companies. The Royal Connaught Hotel served as headquarters for the conference activities. Typical of the many reunions of old friends are the photographs (1) showing J. H. Vohr, Freeman Dyke and R. B. Kraft, and (2) J. P. Quinn and S. A. Swetonic.

2

Monday afternoon was devoted to an inspection trip to the plant of Dominion Foundries and Steel, Ltd. The visitors were particularly impressed by the great diversity of product in this relatively small plant, and by the facility with which operations had been switched over to war-time footing. Among interested visitors to the plant were D. A. McArthur, E. W. Trexler, D. O. Davis and H. D. Robb (3).

A technical session was held Monday evening, at which papers were presented by C. J. Porter, shown with A. F. Kenyon (4), and by D. O. Davis. The meeting was preceded by a dinner, presided over by T. E. Hughes, president of the Association, shown (5) with H. G. Hilton. Among the active participants in the conference was F. E. Flynn (6), snapped as he was greeted by R. L. Beamish.

3

A second technical session was held Tuesday morning, with papers presented by J. R. Green, J. P. Ditchman, and H. A. White (7). Tuesday afternoon witnessed an inspection trip to the Hamilton plant of the Steel Company of Canada, Ltd., which represents almost half of the steel production capacity of Canada, and is devoting primary efforts to production for direct and indirect war needs. The photograph (8) shows R. O. Horning, J. R. Bottoms, R. M. Lang and W. L. Clayton on this inspection trip.

4

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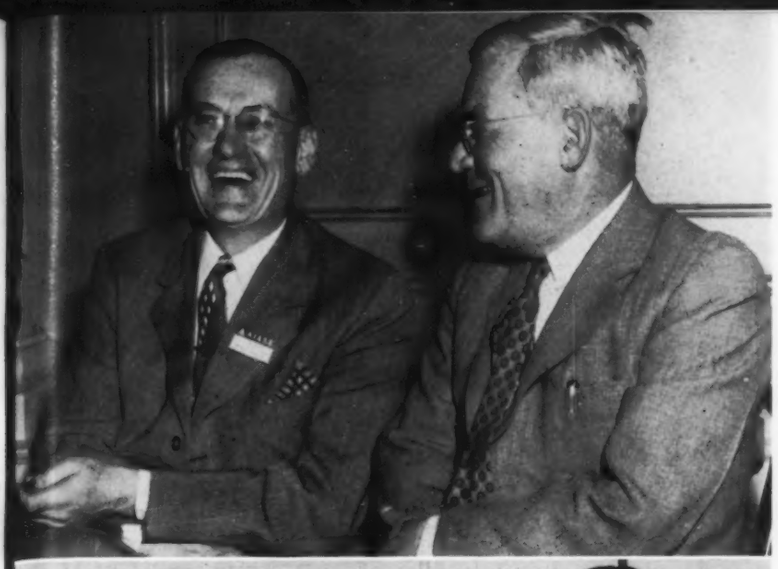

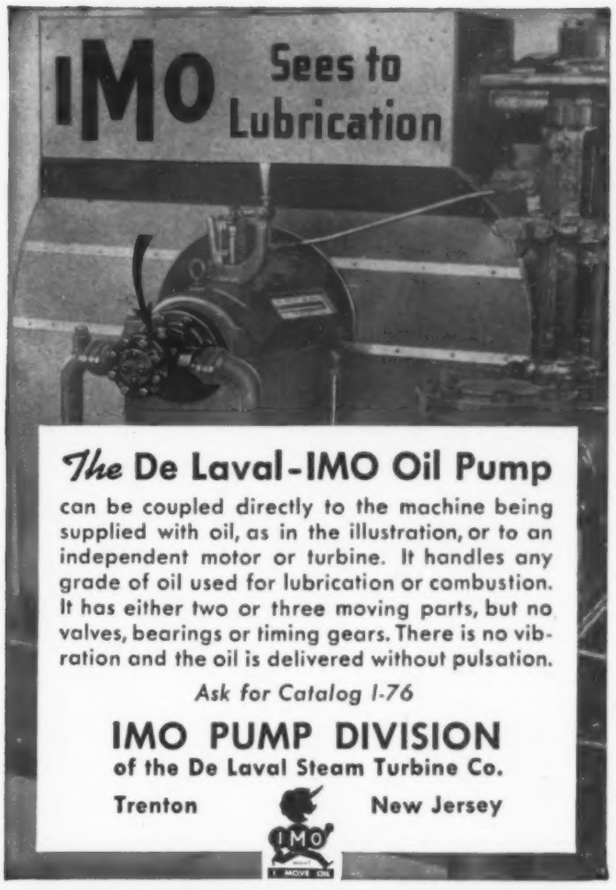

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can be coupled directly to the machine being supplied with oil, as in the illustration, or to an independent motor or turbine. It handles any grade of oil used for lubrication or combustion. It has either two or three moving parts, but no valves, bearings or timing gears. There is no vibration and the oil is delivered without pulsation.

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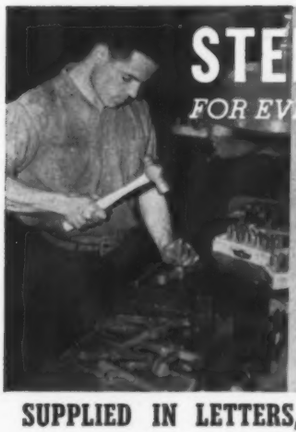

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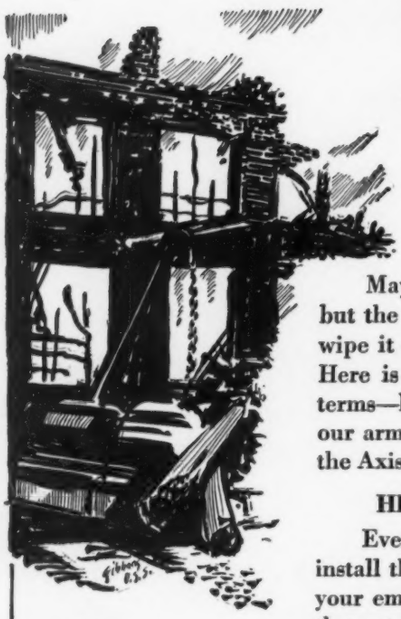

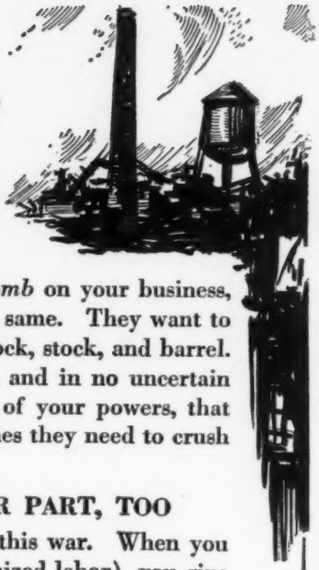

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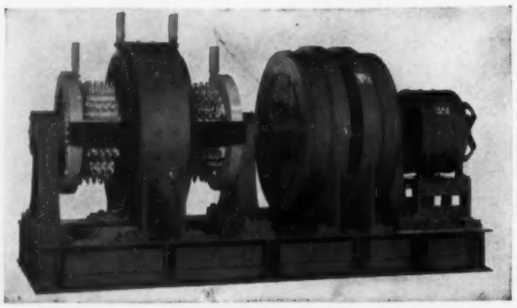
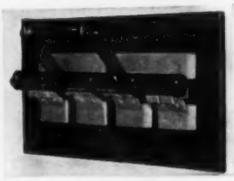
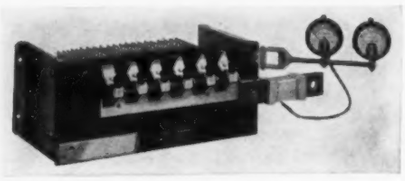


In these days of speed, speed, speed, you'll want to know the facts about Columbia Low Voltage Generators, Plating Tank Rheostats and Reversing Switches. For more than 15 years these Columbia products have been meeting the production and quality demands of the plating industry and, of relatively equal importance, we have them available now for prompt shipment.

Write us your needs and we will send you complete information immediately.

Columbia Low Voltage Generators are built in sizes of 100 to 20,000 amperes, 6 to 60 volts. They are available for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes; for anodic treatment of aluminum in sizes of 30, 40, 50 and 60 volts, 500 to 5,000 amperes.
Columbia Reversing Switches are of the double pole, double throw type for use as reversing switches or series parallel switches on circuits up to 15 volts, 200 to 2,000 amperes.
Columbia Rheostat sizes range from 15 to 5,000 amperes and with a 3 to 6 volt drop.





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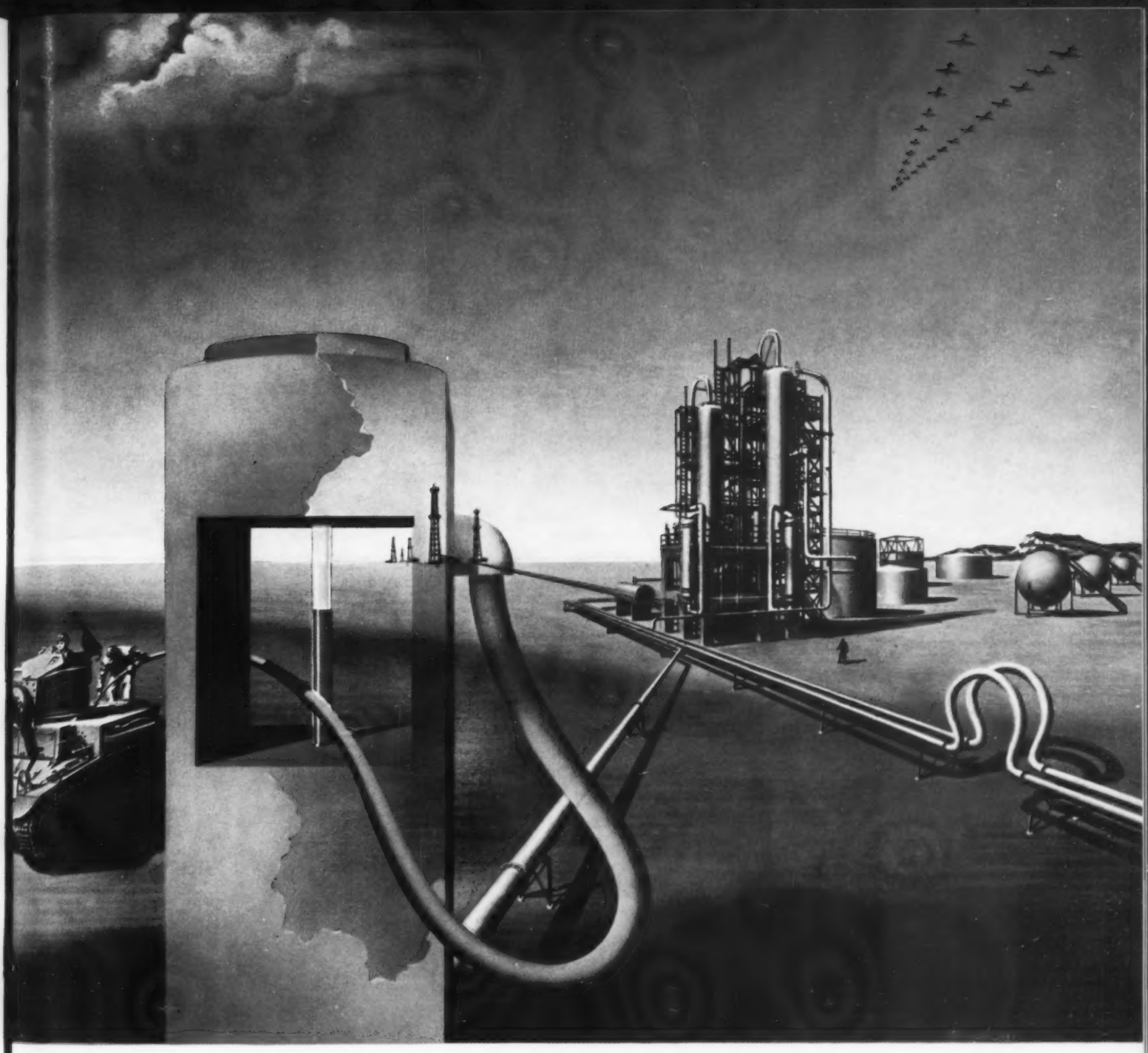

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When you hear, with bated breath, how close the enemy has come to a victory with some raid of fifty or a hundred planes, you may wonder what merciful fate kept them from using a thousand. It was more likely lack of *fuel*, not fate, that stayed them.

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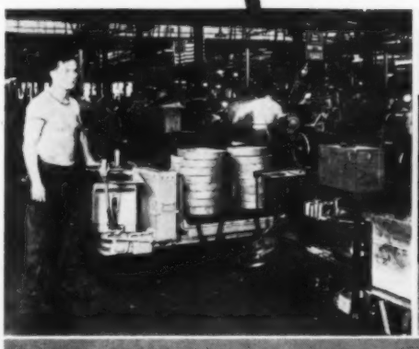

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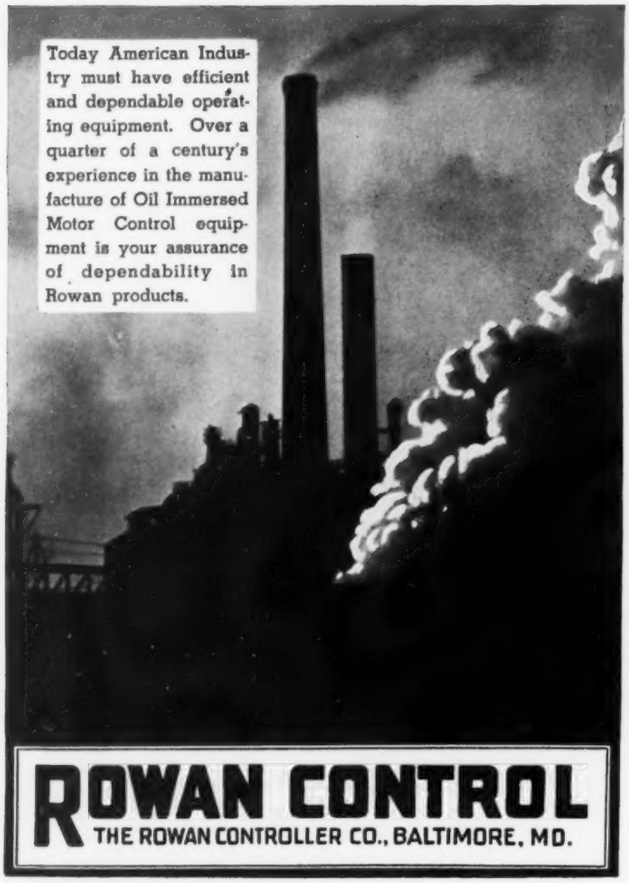
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Annual Convention

SEPTEMBER 22-23-24 1942

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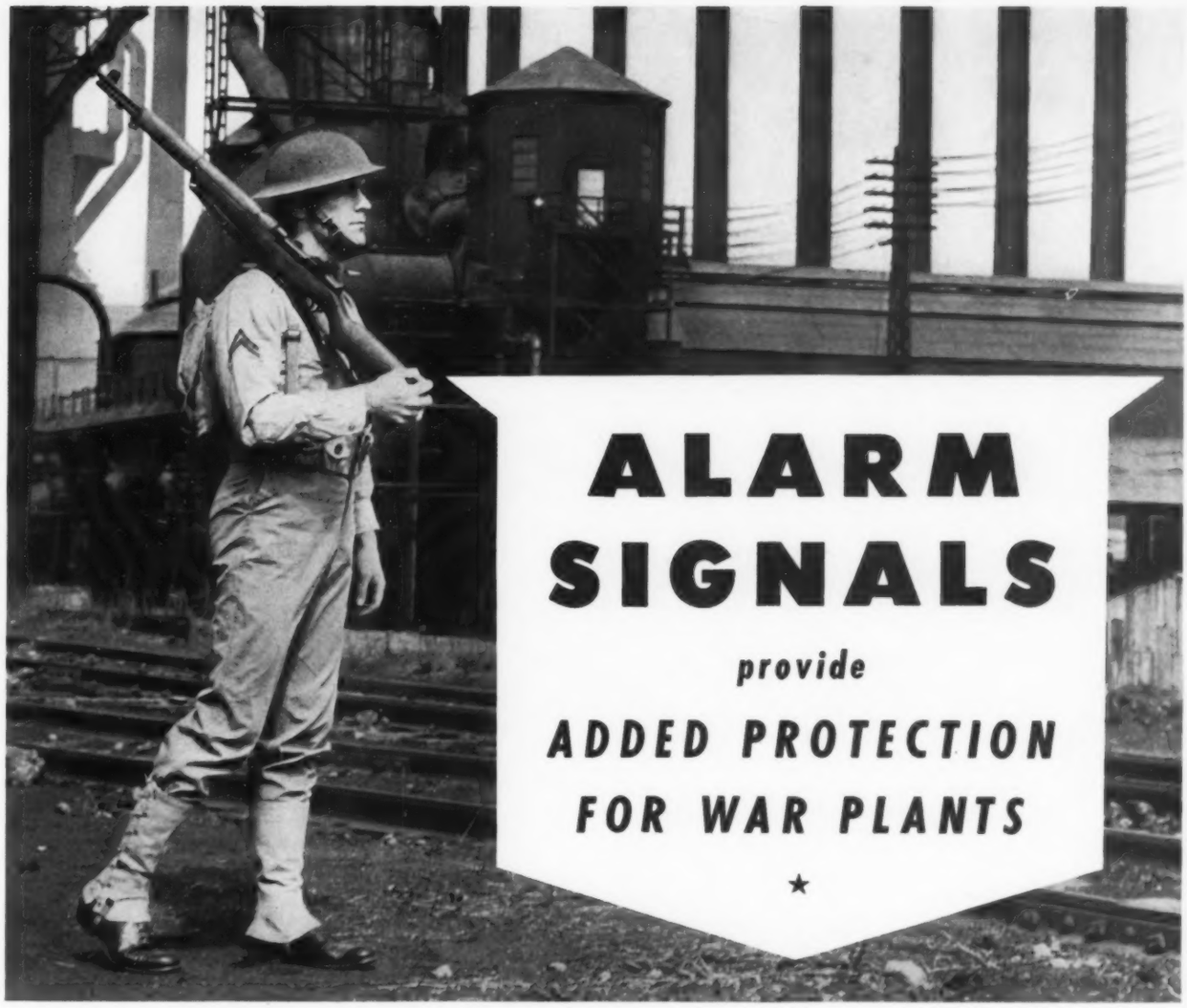

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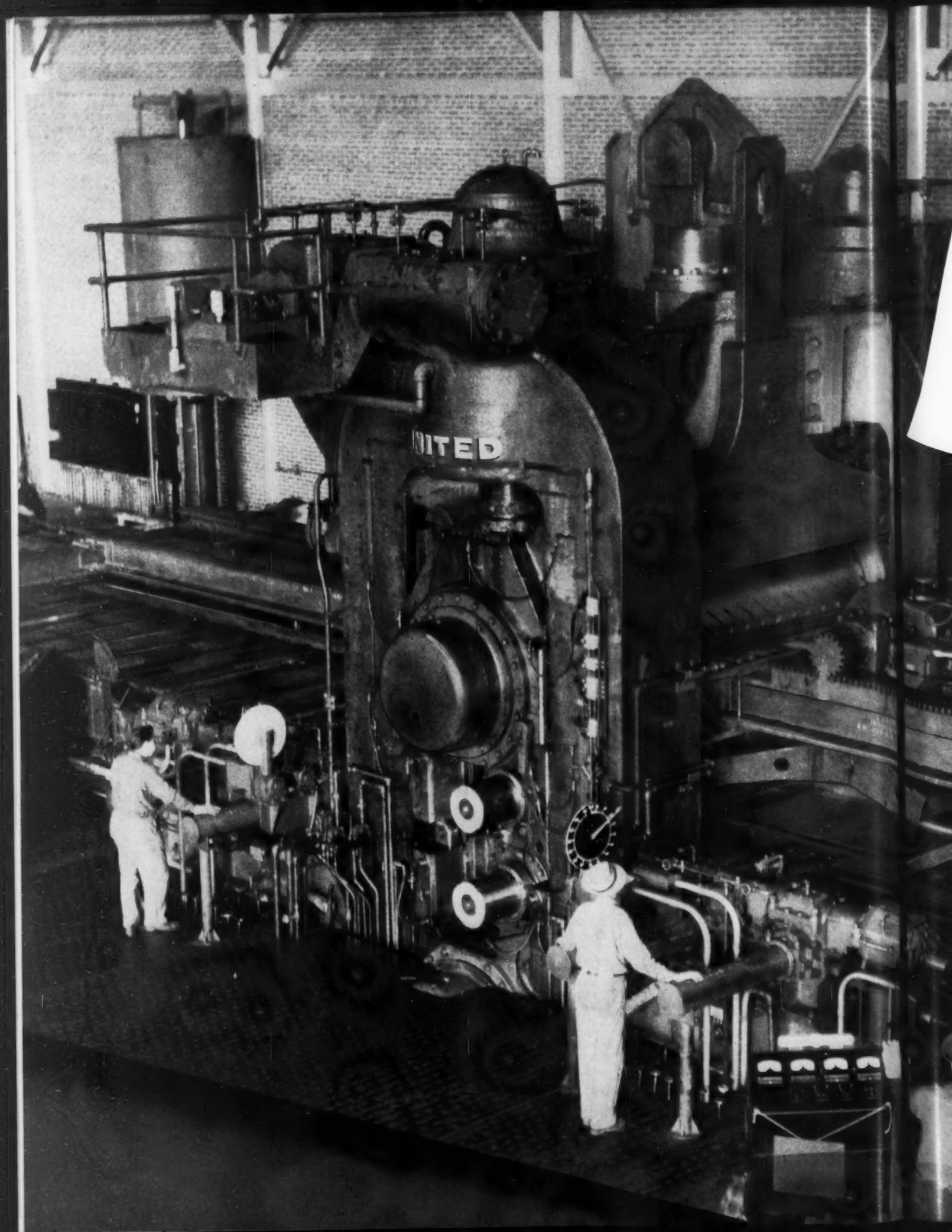
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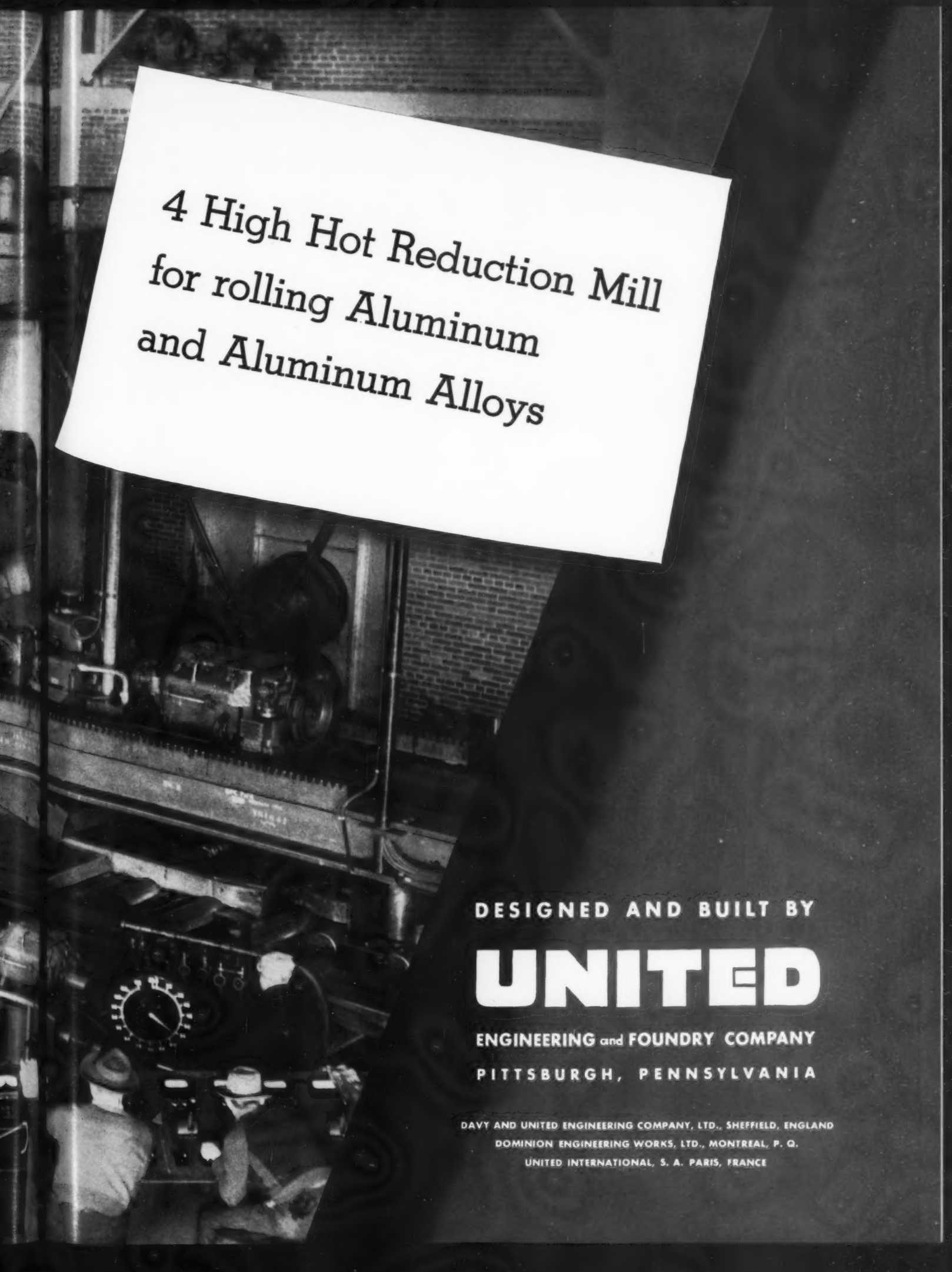
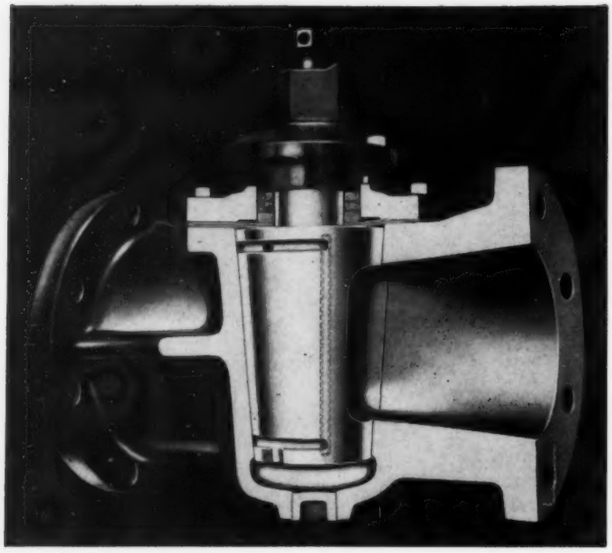

4 High Hot Reduction Mill
for rolling Aluminum
and Aluminum Alloys
DESIGNED AND BUILT BY
UNITED
ENGINEERING and FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA
DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND
DOMINION ENGINEERING WORKS, LTD., MONTREAL, P. Q.
UNITED INTERNATIONAL, S. A. PARIS, FRANCE



The *Strongest* Line of Defense against Leakage

Selection of Nordstroms is an engineering axiom for defense against leakage. The majority of main gas transmission lines installed during the last five years are Nordstrom-controlled. The same is true in the case of refineries. Every leading recycling plant relies on Nordstroms for important line control. In every high pressure oil drilling field there's a regiment of Nordstroms—particularly Hypreseals on mud lines where valve cutting takes heavy toll in ordinary valves. Check the principal chemical plant installations and there again it's a Nordstrom victory, for Nordstroms fully defend themselves against corrosion, erosion, extremes in temperature and pressure.

MERCO NORDSTROM VALVE CO.

A Subsidiary of Pittsburgh Equitable Meter Co.

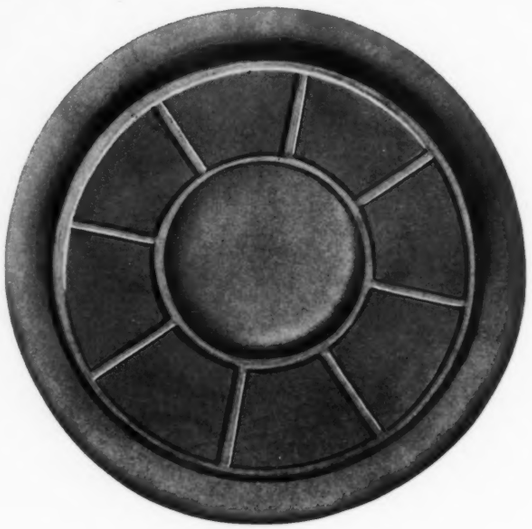
WORLD'S LARGEST MANUFACTURERS OF LUBRICATED PLUG VALVES; GASOLINE, OIL AND GREASE METERS

Main Office: 400 Lexington Avenue, Pittsburgh, Penna.

SALES OFFICES: Boston, Brooklyn, Buffalo, Chicago, Columbia, Des Moines, Houston, Kansas City, Los Angeles, Memphis, New York City, Philadelphia, Pittsburgh, Seattle, San Francisco, Tulsa

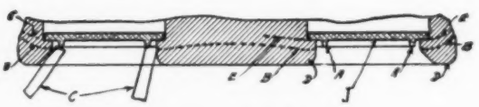
NORDSTROM VALVES

Ohio Magnet Outer Rings Seldom Break



The bottom or wearing face of an Ohio Magnet presents a solid long lived surface to the work.

The annular rings on the manganese bottom plate prevent dangerous wear of steel pole shoes, so bottom plate cannot sag. **See cut below.**



Note wear line B B B

There are no holes or depressions to start wear or cracks.

These features result in

LOW MAINTENANCE COST.

OHIO reliable MAGNETS

The OHIO Electric Mfg. Co.
5907 Maurice Avenue
Cleveland, Ohio

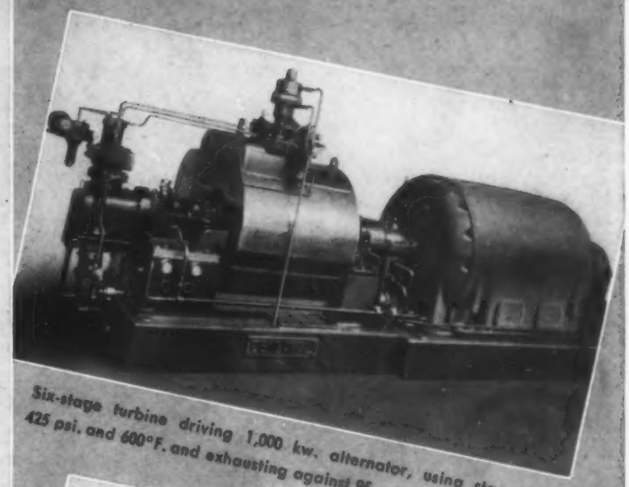
DE LAVAL TURBINES *for* AC or DC Generators

De Laval steam turbines of improved modern design, using high-strength alloys for parts subject to high temperatures and high stress, are now available for direct connection to alternators in capacities up to 15,000 kw., and with double helical speed reducing gears, for driving direct current generators of the same capacities.

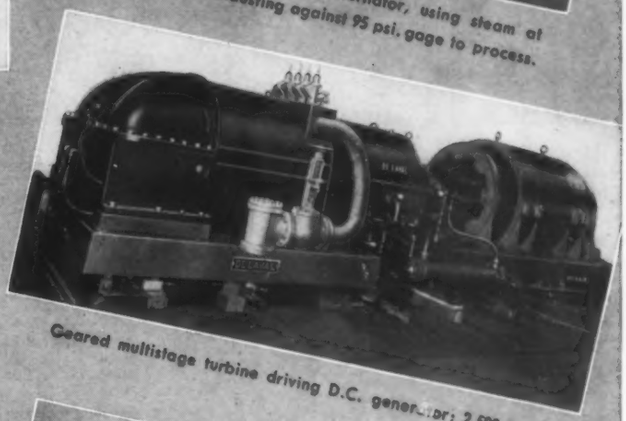
Scientific design of rotors and blading, stream-lining of flow passages and separation of moisture from the steam during expansion make possible higher speeds and better steam economies.

State your conditions and ask for Publication T-3524.

Triple-casing turbine geared to alternating and direct current generators. This type of turbine is highly efficient with steam at high pressure and temperature.

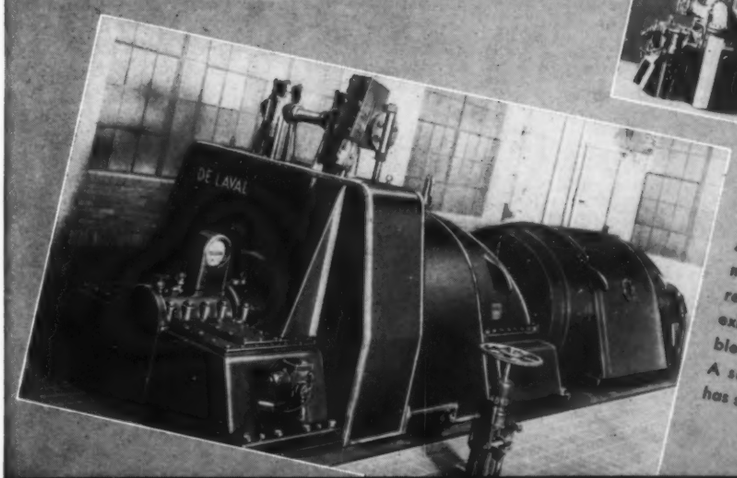


Six-stage turbine driving 1,000 kw. alternator, using steam at 425 psi. and 600°F. and exhausting against 95 psi. gage to process.



Geared multistage turbine driving D.C. generator; 2,500 kw.

Geared turbine driving D. C. generator; 2,500 kw.; steam is bled to process.

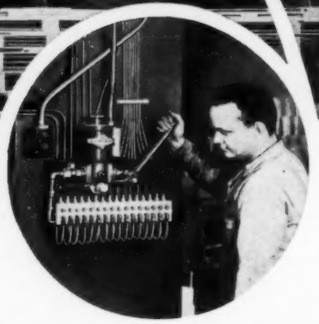


Multistage turbine driving 4,000 kw. (5,000 kw. maximum) 60 cycle alternator. The turbine receives steam at 425 psi. and 720°F. and exhausts to condenser, with provision for bleeding at the 6th, 11th and 15th stages. A similar De Laval unit rated at 6,000 kw. has since been ordered.

DE LAVAL *Steam Turbine Co.*

TRENTON, N. J.

MANUFACTURERS OF: TURBINES · STEAM HYDRAULIC PUMPS · CENTRIFUGAL PROPELLER ROTARY DISPLACEMENT · MOTOR MOUNTED · MIXED FLOW · CLOGLESS · SELF PRIMING CENTRIFUGAL BLOWERS and COMPRESSORS · GEARS · WORM HELICAL and FLEXIBLE COUPLINGS



LINCOLN CENTRO-MATIC LUBRICATING SYSTEMS

lubricate all bearings from a single source

Overhead traveling cranes have been lubricated the Lincoln way for many years—and are still giving dependable, trouble-free service. As shown in the above circle, a man can stand in the cab, pull a lever back and forth a few times and a predetermined amount of lubricant will be delivered through a centralized system to each bearing on the crane. No lost motion . . . No lost time . . . This easy operating, dependable system can be installed, not only on cranes, but on any type machinery having bearings requiring grease lubrication.

War production must be kept rolling—and to keep machines and equipment going at top speed, the need for positive and speedy lubrication of bearings becomes a factor of vital importance.

Cut production delays and lower your lubrication and maintenance costs by equipping your machines with Lincoln CENTRO-MATIC Lubricating Systems.

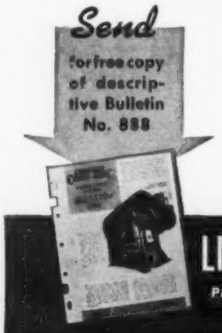
These modern lubrication systems are easily installed on new or old machines. They make it possible for all bearings on a machine to be lubricated from a single source, and machines can be run day and night without taking time out for lubrication service.

A Centro-Matic System is a centralized system consisting of a number of Centro-Matic injectors—one for each bearing—and a suitable Lincoln pump for delivering the lubricant under pressure to the injectors.

The injectors may be grouped in one location or separately at each bearing. In either arrangement only a single lubricant supply line is required.

The lubricant pump may be hand or power operated. Power operated systems may be semi-automatic or full automatic.

Send us the specifications of the machinery to be lubricated. Our engineers will gladly make recommendations. No obligation.



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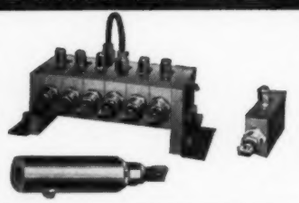
LINCOLN ENGINEERING COMPANY

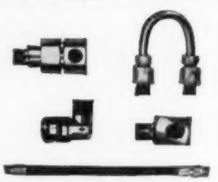
Pioneer Builders of Engineered Lubricating Equipment

ST. LOUIS, MISSOURI

SIMPLE TO INSTALL



Lincoln CENTRO-MATIC injectors are furnished in two types—Block type for manifold grouping. Cylindrical type for widely spaced bearings.



Lincoln grease line accessories—High pressure fittings and adapters, connectors, connector tube assemblies, compression couplings, bushings and lubricant hose.

Lincoln Model 1840, Fully-automatic Electric Lubrigun, 30-lb. capacity.

Lincoln Model 1805, Manually operated CENTRO-MATIC pump, 2-lb. capacity.

I'M HELPING VICTORY PRODUCTION BY RETURNING OXYGEN AND ACETYLENE CYLINDERS PROMPTLY
ARE YOU DOING YOUR PART?
LINDE OXYGEN
PREST-O-LITE ACETYLENE
RETURN EMPTIES TODAY

● For posting on bulletin boards and shop walls in Linde customers' plants, a two-color version of the poster shown above is available. These posters will remind your employees of the vital need for fullest utilization of existing stocks of oxygen and acetylene cylinders and will thus help assure your gas supply. Ask any Linde office for the quantity you require, specifying Form 5105.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street, New York, N.Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

LINDE OXYGEN . . . PREST-O-LITE ACETYLENE . . . UNION CARBIDE
OXWELD, PUROX, PREST-O-WELD APPARATUS . . . OXWELD SUPPLIES

The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks of Units of Union Carbide and Carbon Corporation.

"NOW I KNOW HOW TO MEASURE A DOLLAR!"

"Frankly, I hadn't looked for so much difference in overhead cranes. But I learned how to apply measuring stick methods when we bought our last one. I learned how P&H could fit our needs exactly with a crane of standard design. How P&H's greater volume and advanced crane building facilities made possible substantial economies. How P&H electrical equipment meant extra dollars in our pockets. And last, but not least, I learned that P&H delivery promises were honest promises. And that's important in meeting today's expanded war production when time is so important."

P&H is America's largest and only crane builder producing complete electrical equipment

Awarded the Navy "E" for excellence in war production, P&H also displays it as a pledge of future effort.

General Offices: 4455 W. National Ave., Milwaukee, Wis.

HARNISCHFEGER
CORPORATION
ELECTRIC CRANES · EXCAVATORS · ARC WELDERS P&H HOISTS · WELDING ELECTRODES · MOTORS

P&H
OVERHEAD CRANES

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Defense Against Short-Circuits

Oil leaks and is thrown from bearings and gets on armatures. Resulting short-circuits cause expense and delays that hold back production.

Drip-less, waste-less NON-FLUID OIL stays where applied, even when subject to heat and vibration. It remains in bearings and off windings — burnouts are avoided. What's more, you save on oil and application cost, for NON-FLUID OIL outlasts oil many times over.

Used successfully in leading iron and steel mills. Send for testing sample today — prepaid — NO CHARGE.

•

New York & New Jersey Lubricant Co.

Main Office: 292 Madison Ave., New York, N. Y.

WAREHOUSES:

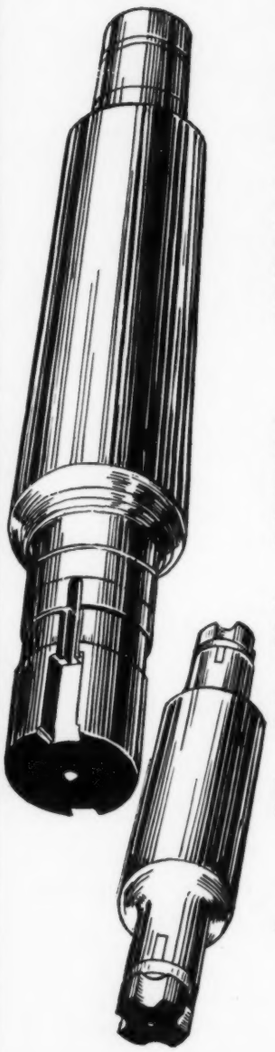
Chicago, Ill. — Atlanta, Ga.
St. Louis, Mo. — Detroit, Mich.
Providence, R. I. — Greenville, S. C.

TRADE MARK REGISTERED
NON-FLUID OIL
IN U.S. PAT OFFICE & FOREIGN COUNTRIES

MODERN STEEL MILL LUBRICANT

Better Lubrication at Less Cost per Month

NATIONAL ROLLS



The Fighting Spirit of Chilled Iron

NO implement of its size or bulk must withstand more crushing abuse than rolls — and this takes more than strength.

It takes *spirit*.

The spirit is in the chilling and hardening, enabling NATIONAL ROLLS to shape and finish steel with metal of superior weight and strength.

Aside from their correct machining and smooth surfacing, NATIONAL ROLLS possess this inherent spirit to fight and defeat the resistance they encounter.

They discharge fully the responsibility they assume.

H. H. Seamon

President and General Manager

THE NATIONAL ROLL & FOUNDRY CO.

Rolls & Rolling Mill Equipment

AVONMORE, PA.

Pennsylvania TRANSFORMERS

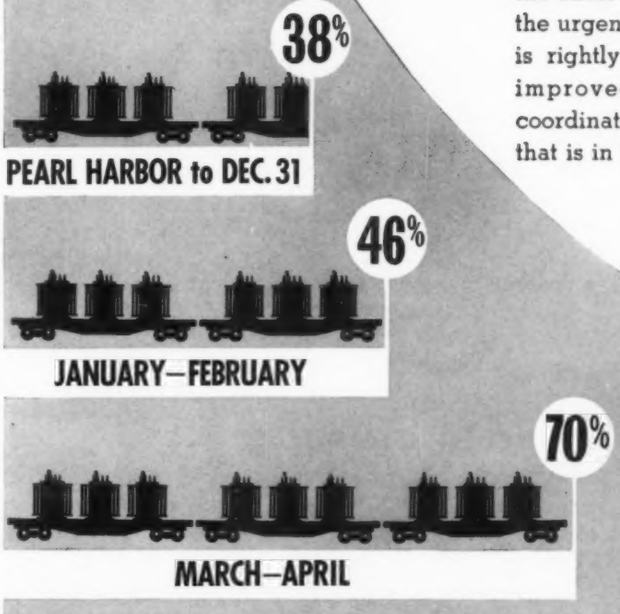
"I am interested these days in just one thing—getting the most war production we can possibly get, and getting it in the shortest space of time."

—DONALD NELSON

Pennsylvania delivers!

AHEAD OF SCHEDULE

MEETING deliveries has always been Pennsylvania's creed. But that was before Pearl Harbor! Today we're out to *beat* delivery promises — to make shipments *ahead of schedule* wherever possible. ¶ Witness the chart below — it's an indication of how we are answering the urgent call for speed — and more speed! ¶ Pennsylvania is rightly proud of this record. It is the result of vastly improved facilities, increased personnel, thorough coordination among all departments, and the *will to win* that is in the heart of every Pennsylvania worker!



Percent of completed orders shipped ahead of schedule.

SOME RECENT ORDERS SHIPPED AHEAD OF SCHEDULE

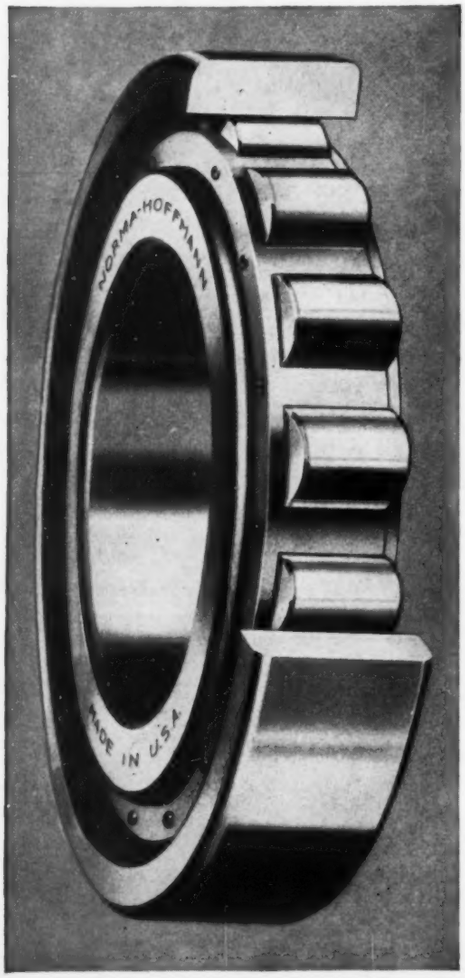
Number	KVA	DAYS AHEAD
4	1000	8
6	500	26
1	5000	25
22	1000	44
4	3000	29
10	1250	8
4	1000	6

Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, N. S., PITTSBURGH, PA.

WHERE NO OTHER ANTI-FRICTION BEARING WILL STAND UP

Picture to yourself the most difficult conditions a bearing can be called upon to meet — high speed, heavy load, temporary overload, shock, vibration. Then read below why NORMA-HOFFMANN PRECISION ROLLER BEARINGS — time-tested heavy-duty units — meet these conditions.



PARALLEL LINE CONTACT

Solid cylindrical rollers between cylindrical races providing maximum load contact area, increased steady load capacity, and a larger shock-absorbing capacity than any other type of single-row bearing.

SAFETY FACTOR

A margin ample for temporary overloads up to 50% beyond normal rating, as under peak loads, in unusually severe duty, or under shock conditions.

SUPERIOR CAGE

Made of extruded bronze to secure maximum density and uniformity, and machined all over for balance.

DURABILITY

Large contact area with the most efficient load distribution—greater wear-resisting surfaces—true rolling between rollers and raceways — minimum friction between roller and cage.

SPEED QUALITIES

A lower friction coefficient under heavy load than any other type of bearing—a speed ability equal to that of any ball bearing, size for size, up to 35,000 R. P. M.

Write for the Catalog. Let our engineers work with you.

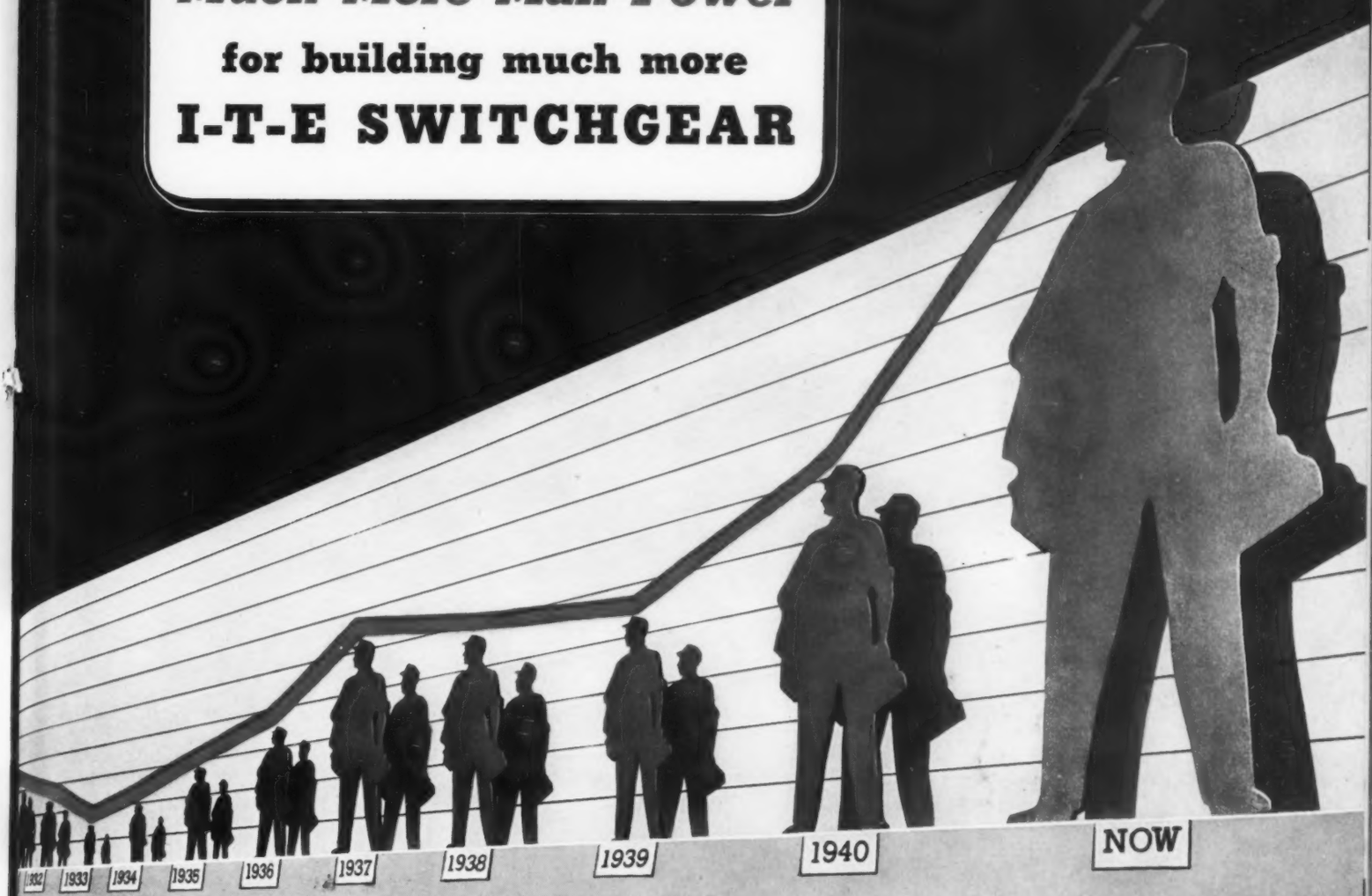
"NORMA-HOFFMANN"

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

Much More Man-Power

for building much more

I-T-E SWITCHGEAR



The training programs which provide new skilled hands rapidly . . . the ability of American people to practice new operations well and quickly . . .

These factors in today's efforts will live in history.

These are the factors which not only produce the demanded quantities of war equipment, they also give assurance that when equipment is called to action it will do its work WELL.

In looking at the chart above, showing increase in personnel, read it in terms of *quantity* and of *skill.* And think of it as typical of American industry.

I-T-E

AIR SWITCHGEAR

IMMERSED IN AIR • ENCASED IN STEEL

Representatives in Principal Cities

CIRCUIT BREAKER CO., PHILADELPHIA, PA.

See How INSULATION STRENGTH Is Built into These D-C FIELD COILS

A Feature of this New D-C Motor

FIELD COILS of G-E direct-current motors are wound with Formex wire for two important reasons:

1. Coils wound with Formex wire—the toughest magnet wire yet developed—have extraordinary resistance to abrasion, heat shock, mild acids, and alkalies. Hence the field coils are built to have strength against any possible short circuits or failure.

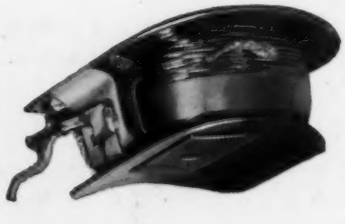
2. Coils can be made more compact when wound with Formex wire. This increases heat-dissipation ability, allows more ventilation space, and reduces possibility of a burnout or "hot spot."

This is only a small part of the story on the new General Electric d-c motor, however. Why not get full details on the entire motor—from built-up commutator and heavy-duty brush rigging to such convenience features as easy reversal without changing any part of the frame, fan, or brush rigging? Call or write your G-E representative for complete information. And be sure to send for your copy of the latest bulletin on d-c motors, GEA-1542E. General Electric Company, Schenectady, N. Y.

•

Unusual Construction of Commutating Field Coils of Smaller Motors

A Textolite box covers the laminated-steel pole piece and is tightly molded into shape under pressure. Tough Formex wire coils are then wound compactly on this assembly. They are then bonded with a thorough, baked-in impregnation of synthetic resin. This results in a rigid, nonchafing, long-lasting assembly.



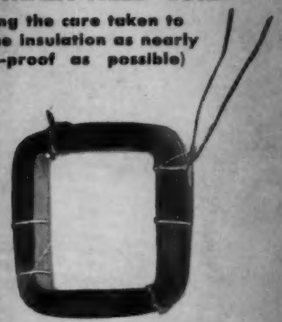
LOOK TO G.E. FOR D-C

GENERAL ELECTRIC

750-71-8398

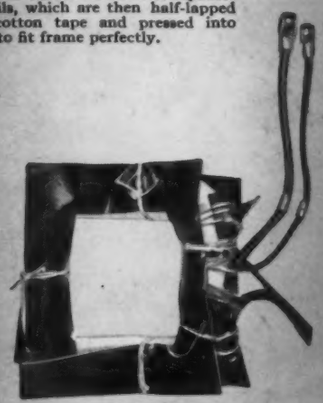
4 STEPS IN THE MANUFACTURE OF THE MAIN FIELD COIL*

(showing the care taken to make the insulation as nearly failure-proof as possible)



Both shunt and series portions are wound with tough Formex wire, in those ratings for which the right Formex wire sizes are available. Coils are wound in pairs, eliminating external connections between them.

Layers of varnished cambric separate the coils, which are then half-lapped with cotton tape and pressed into shape to fit frame perfectly.



Varnished cambric is again applied—to both sides of the coil for additional protection.

After final cotton taping has been applied, coil is thoroughly impregnated with insulating varnish, baked, and given a final, heavy coat of 1201 Glyptal Red. *This complete treatment cements the coils into a solid mass that offers high resistance to electrical breakdown or mechanical injury.*

50-hp motors and smaller